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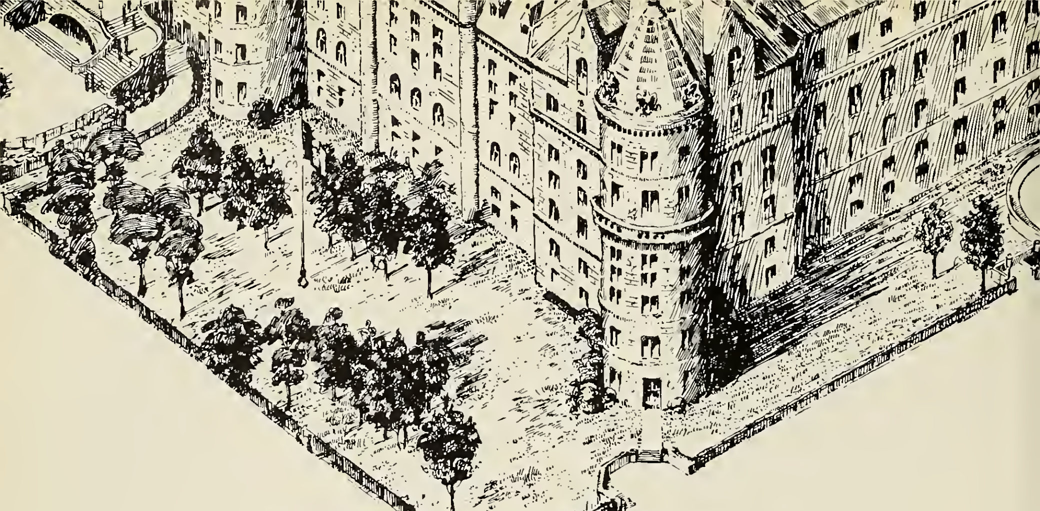

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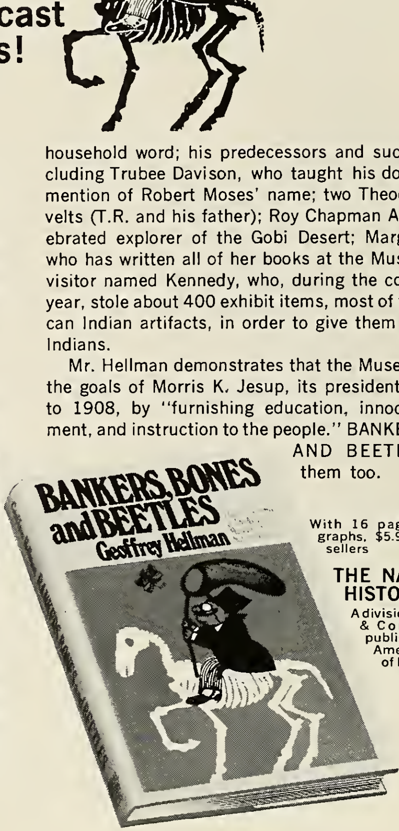
Regardless of how often you've visited the Museum yourself, or how much you've heard about it, with Mr. Hellman as your guide, you'll see sides of it even we didn't know existed. He starts by introducing you to founder Albert S. Bickmore, who marked his formative years in Maine watching the annual migration of the Wild Goose, and later lost his footing and nearly his life exploring a volcano in the Spice Islands. "My only hope was to seize that fern," Bickmore wrote subsequently. He did, and came to be known as "the father" of the Museum. Another man, not generally known for his good works, can be said to have been the godfather, because of the way he smoothed the establishing legislation: Boss Tweed.

Then, beginning with the cornerstone-laying, at which President Grant's Tiffany trowel was swiped and the cornerstone disappeared, you will be present at all the key moments in the Museum's first hundred years. You'll meet such figures as Henry Fairfield Osborn, the great Museum President who made "dinosaur" a household word; his predecessors and successors, including Trubee Davison, who taught his dog to bark at mention of Robert Moses' name; two Theodore Roosevelts (T.R. and his father); Roy Chapman Andrews, celebrated explorer of the Gobi Desert; Margaret Mead, who has written all of her books at the Museum; and a visitor named Kennedy, who, during the course of one year, stole about 400 exhibit items, most of them American Indian artifacts, in order to give them back to the Indians.

Mr. Hellman demonstrates that the Museum has met the goals of Morris K. Jesup, its president from 1881 to 1908, by "furnishing education, innocent amusement, and instruction to the people." BANKERS, BONES AND BEETLES meets them too.



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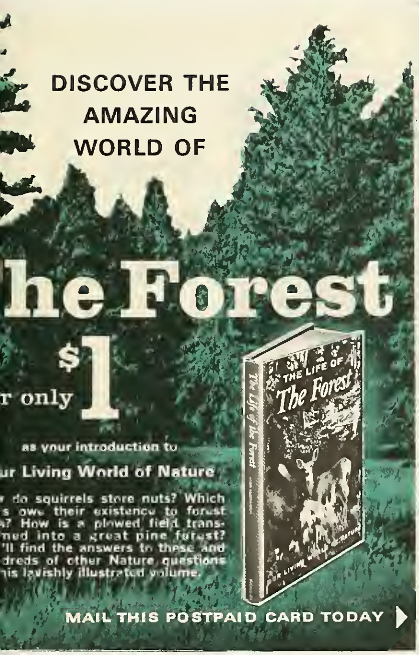
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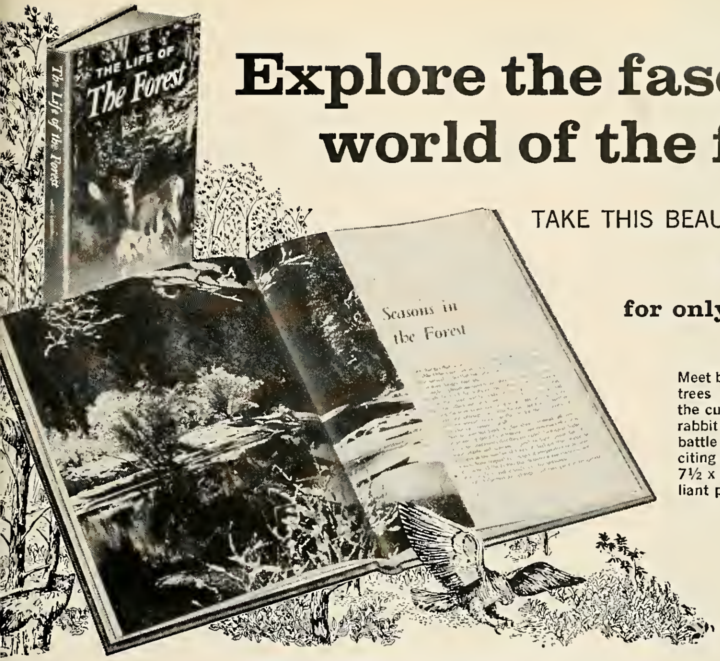

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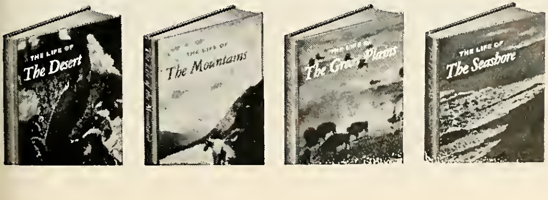

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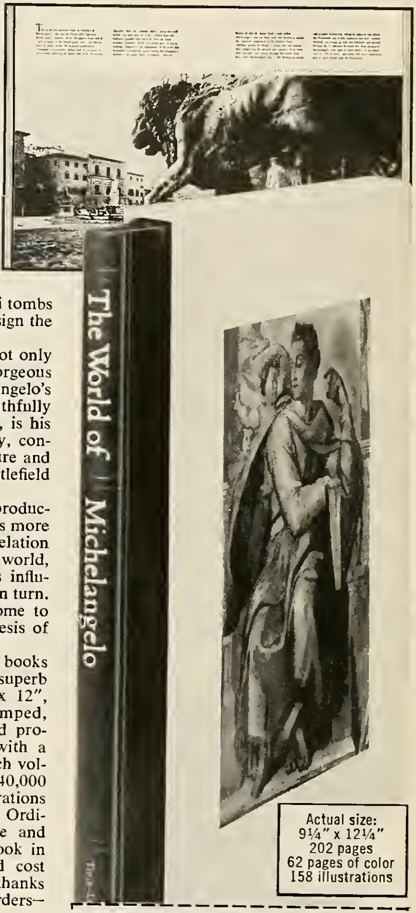

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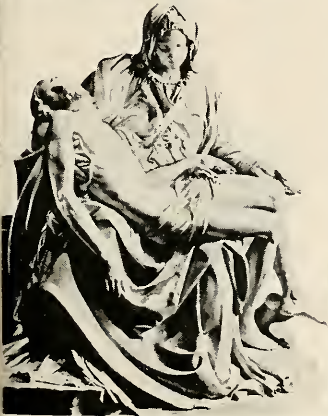

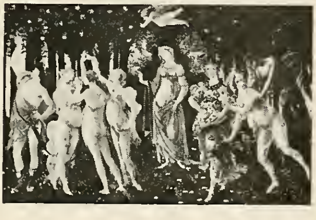

Above, Michelangelo's celebrated Pietá. The book also shows works by Raphael, Giotto, many others. At right, Botticelli's Primavera.

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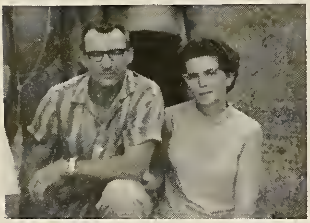
THE AUTHORS

Ivan Schoen, one of the missionaries who contacted the practically unknown Wama or Wayarekule tribe in Surinam, S.A., first went to that country in 1961 with Door to Life Ministries, which later merged with the West Indies Mission. He and his wife, both trained in missionary medicine and dentistry, live in the Wayana Indian village of Apetina in the interior of Surinam, where Mr. Schoen co-ordinates the work done by jungle missionaries with the Trio and Wayana tribes. His report is introduced by Robert Carneiro, Associate Curator of South American Ethnology at The American Museum.

A three-month trip to West Africa last spring inspired Marlyn Mangus' article on the Niger River, as well as several newspaper stories on Africa. Miss Mangus. currently a scientific assistant in the Department of Vertebrate Paleontology at The American Museum of Natural History, holds a masters degree in geology from Columbia University. She previously coauthored "Fossil Lakes from the Eocene" (Natural History, April, 1965).


Ivan Schoen

Marlyn Mangus

John T. Bonner

John T. Bonner is Chairman of the Department of Biology at Princeton University. His research has been concentrated on the development of the "lower organisms," especially the slime molds; he named and discovered the role of the chemical "acrasin" in the aggregation of single cells to form multicellular organisms in slime molds. The recipient of many awards and fellowships, Dr. Bonner is a frequent contributor to learned journals, and author of several books, including *Morphogenesis: An Essay on Development.* His article this month is adapted from a chapter of his book *The Scale of Nature,* to be published by Harper & Row in the spring.

Syd Radinovsky took the photographs for his story on insects of West Bengal while doing biological and ecological research in India with the Johns Hopkins University Center for Medical Research and Training. Dr. Radinovsky is Associate Professor of Biology at Millersville State College in Pennsylvania and Research Associate in the Department of Pathobiology at Johns Hopkins. His publications include many articles on the biology and behavior of mites, as well as two previous contributions to Natural History (November, 1964, and July, 1966).

Syd Radinovsky

Julian Kane

Julian Kane's article on Iceland geology was drawn from his 1964 trip, which also produced his piece on the volcanic island of Surtsey (Natural History, March, 1967). He is a lecturer in the geology department of Hofstra University and teaches earth and space science at Garden City Senior High School. Last April, Mr. Kane received an award from NASA and the National Science Teachers Association for work with high school students on lunar geology research problems.

Probably no one is more familiar with the work of the late Dr. Theodore C. Schneirla than Ethel Tobach, who was his student until his death last August. Dr. Tobach came to The American Museum's Department of Animal Behavior in 1950, as a volunteer research assistant to Dr. Schneirla. She has since collaborated on research and jointly authored many papers with him. She is now Associate Curator of the Department of Animal Behavior; her photograph shows her setting live traps for kangaroo rats at the Museum's Southwestern Research Station, Portal, Arizona, for her studies on the emotional behavior of rodents.

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In and Out of the Field

Alfred Meyer

"Come on up to my office and we'll get a dinosaur sandwich," said Gardner Stout, the newly installed president of The American Museum of Natural History. A wiry, fast-moving man, we remembered meeting him last year at the museum's reception to mark the publication of a book he edited, *Shorebirds of North America*. The reception also gave us a chance to meet the book's author, Peter Matthiessen, a man whose other works—*Under the Mountain Wall* and *At Play in the Fields of the Lord* —we had long admired. We liked Mr. Stout instantly because he smiled a lot and seemed warm and agreeable. Moreover, he'd made such a good choice in getting an author for the shorebirds book. We liked Mr. Matthiessen, too, but were keenly disappointed to see him in evening clothes, having thought of him until then only as a writer who was always either in the bush or on the road.

We did not talk with Mr. Stout again until we were invited up to his office for those dinosaur sandwiches, which tasted suspiciously like the roast beef served in the museum's cafeteria. We were on to vast topics in short order.

"Two important events will take place in 1969," Mr. Stout informed us. "The first is that The American Museum is celebrating its centennial; the other is that a man will probably have walked on the moon by this time next year. That's exciting, they're both exciting. I wonder if our planetarium shouldn't somehow get involved. Or, why doesn't NATURAL HISTORY print a special supplement, something like 'A Stroller's Guide to the Moon' "?

Suddenly we wanted to talk about that, and how to do it. Then we remembered that we were interviewing Mr. Stout: not vice versa. We filed away the idea, as well as a little note to ourselves saying that if we ever wanted to be president of anything, we would have to learn how to make people suddenly want to explore things.

We got back to business by congratulating him on his appointment and asking whether he felt he had a mandate for office and, if so, what it was. He told us that New York had three great cultural institutions—Lincoln Center, The Metropolitan Museum of Art, and The American Museum of Natural History.

"Obviously, it's the third one I care most about," he said. "And I would hope to stress its role in the adult life of this community—indeed, of this country. I have occasionally been taken aback on realizing that so many people think a museum like ours is exclusively for children. With the problems our world faces—food, environmental pollution, and so on—just think how relevant our perspective as scientists and naturalists is."

The president's office is in one of the museum's turrets, and its windows face south. The floor plan is simple: take a circle and draw a line across the top third. That's the president's third of the turret. The rest is for his staff. All of it is paneled. There is a little door between the two parts of the turret, and it reminded us, inexplicably, of the narrow doors on certain European railroad cars.

Mr. Stout told us that he had arrived on the museum scene at an early age. "My father took me to a reception for Admiral Peary at the Metropolitan Opera House in 1910. Peary knew many of the museum' trustees and had received encouragement, and on occasion, support fron them. Anyway, I met him and he wa truly something. Nine feet high an four feet wide. He was magnificent He was my hero. Then, maybe a wee later, I was taken to the museum itse and there, in the hall of North American Birds, I saw the diorama of th peregrine falcon on the palisades o the Hudson River. The diorama i still there, although it has been muc dusted and otherwise refurbishe since then. Well, something happene when I saw that peregrine. I though 'Will I ever get to see a real bird lik that?' I've been interested in bird ever since, and have watched the all over the world. I can't help wondering now how many scientists ha that first feeling of awe over a creature or a group of creatures righ here at the museum. When it come right down to it, a lot of the busines of this museum is magic like that We're involved with the imaginatio as well as with science. The two ofte go together."

The phone rang, and, since we ha finished what finally did prove to b a roast beef sandwich, we took ou leave and slipped out through th narrow door.

We thought about Mr. Stout late on. He had spent much of his working life on Wall Street and, befor retiring, was chairman of the executive committee at Dominick & Dominick, a well-known investment firm He knows a great deal about finance which is important, particularl if you're president of a nonprofit institution. We also though about new presidents, since it seem

Continued on page 6

handful of people like Mary Carnwath e trying to keep our promise to the Indians. ut they won't make it without you.

The Hopi Indians' village of aulovi in Arizona sits on land oor, infertile and inhospitable so far nobody has tried to take ay from them.

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he $15.00 a month contrib- by Mary Carnwath is provid- remarkable number of things race and her family.

race will have a chance to con- schooling. The family has able to make its home a little livable. And with the money ver, together with funds from sponsors, the village has been o renovate a dilapidated build- r use as a village center. The r now has two manual sewing ines that are the beginnings of ll income-producing business. nly a small beginning. More y and more people like Mary wath are needed. With your perhaps this village program

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Contact with the Stone Age

by Ivan L. Schoen

The stone ax, once the distinctive cutting tool of all Amazonian Indians, has today virtually disappeared from use. During the last dozen years only three South American tribes became known that still used the stone ax—the Amarakaeri and Isconahua of eastern Peru and the Xetá of southern Brazil. Since their discovery, however, these tribes have either perished or else replaced their stone axes with steel ones. Now, with the rediscovery of what appear to be the isolated Wama in the rugged southeastern corner of Surinam, another Stone Age people has come to light.

Not only do the Wama still use the stone ax, they are also completely nomadic and subsist entirely by hunting, fishing, and gathering, with no agriculture. Thus they appear to rank as the most primitive Indian culture left in the New World.

Originally discovered in 1937 by an expedition surveying the border between Surinam and Brazil, the Wama were not seen again for thirty years, and there was some question as to whether they still existed. The missionary's report that follows describes the way in which peaceful contact was established with these elusive and suspicious people, and tells what was learned of their mode of life during the single day that the missionary party was allowed to remain with them.

While very little is yet known of Wama culture, it is clear that they speak a Carib language. Since all other Carib speakers, from the Antilles to the Mato Grosso, practiced agriculture, this raises an interesting problem: Did the Wama once cultivate and later abandon the practice, or are they the sole remnant of a time when the Caribs knew no agriculture? If the Wama survive long enough to be studied ethnographically, we may some day know the answer to this question.

Robert L. Carneiro

Wama man and child. This photo is from a 1937 Dutch survey expedition.

Since 1965, members of this mis- n have made several expeditions determine whether or not any embers of the Wayarekule or ama tribes still survive. Such evi- nce as footprints, campsites, and scarded articles—fans, string, bas- ts, animal bones—have led us to lieve that there are, in fact, sur- vors. Consequently, we have been epared to move quickly to investi- te any information that may lead a contact with these people.

The latest lead, which did cul- nate in a successful contact with group of very primitive Indians, me from four Wayana Indians mong whom we normally work) Thursday, June 13, 1968. In this ort, we will endeavor to document detail all the events leading up and including, the actual contact t we made.

On June 8, 1968, a canoe carrying ht Wayana Indians was drifting wn the Waremapan. The boat and ee of the Indians — Kuwaiman, nmi, and Aleukani—were in the ploy of a mapping project. The er occupants were Indians return- to Surinam from the Jarí River Brazil. Their canoe had broken and they were catching a ride h the working Indians. They were paluika, his wife, mother, and two ll children.

While they were drifting quietly, y heard the noise of what they sumed to be wild pigs running ough the shallow water at the ded edge of the bush. Two of the n. Kuwaiman and Ponmi, jumped ore to give chase, while the canoe tinued to drift down the creek. idenly Kapaluika, who was sitting the front of the canoe, saw five nge Indian men peering out at from the bush. (The original ort stated that two women were seen running through the bush, the larger group was encoun- d. But that was not the case. The above are verified facts). About this time, the men who had given chase arrived on the scene. They exchanged greetings but with very little understanding. Then, as they talked, Kuwaiman, who is bilingual, speaking both Wayana and Trio, discovered that the language of these strange Indians was close to Trio. From that point on he spoke to them in Trio, and found that they could converse quite freely. They talked for almost an hour. The Wayanas asked them where their village was, and they replied that it was just over the hill. Since the people were not reluctant to lead them to their camp, the Wayanas left one man with the women and boat, and the other three men went with the strange Indians to their camp. As they neared the camp, one of the Indians called ahead that they had seen strangers and were bringing them into the camp. Their leader shouted back, and the women and children ran and hid. Once they had entered the camp, however, the people crowded around them, talking, trading, and endeavoring to get their possessions. They did succeed in stealing two machetes and a shotgun. At this point, the Wayanas decided it would be prudent to try to return to their boat, which they were able to do without incident, although there had been much talk of shooting. Several of the strange Indians followed them and wanted to get into all the possessions the Wayanas had in their canoe, but they were able to push away from the bank and came directly to the mission post near Awarasoela.

The above report was given by Mrs. Ford and the Indian Kapaluika over the radio to missionary Dean Ford, and then to the interior coordinator of the mission, Ivan Schoen. The report was received on Thursday, June 13, 1968. It was decided to prepare an immediate expedition to validate the report and to make further contact with the Indians. We began to gather equipment and personnel at the Lawa Mission Post. In order to enhance the possibilities of communication with this new tribe, we brought Indians from the Alalaparu and Tepoe areas, and Wayanas from Paloemeu, Apetina, and Lawa. All told, these Indians had at least a partial knowledge of six different Indian languages: Wayana, Trio, Apalai, Wayapi, Wai Wai, and Emerillon. Included in the equipment was a shortwave radio so that we could immediately relay any important findings to interested government officials, and report any emergency that might arise. Mr. Draper handled communications, and the other interior stations stood by to relay. With the co-operation of the Missionary Aviation Fellowship, all necessary equipment, supplies, and personnel were finally assembled at the Lawa Post by Wednesday, June 19, 1968.

The following day, the expedition departed. It was made up of fifteen individuals: five Wayana Indians, five Trio Indians, and five Americans (Mr. and Mrs. Ivan Schoen, Mr. and Mrs. Art Yohner and Dean Ford). Included in the Indian party were the wives of two of the Trio men and the wife of one of the Wayanas. We had several reasons for taking women along. First, it would be less likely that we would be taken for a war party if women were in evidence. Second, the men work harder and remain in better humor when women are along to do the cooking and camp chores. And last, we have found that the presence of ours wives tends to make the Indian women more cheerful. The Trios told us years ago, when we first went to live with them, that one of the reasons they felt they could trust us was that we had brought along our wives and children. This had indicated that we intended no harm to their women and children.

Our canoes were heavily loaded,

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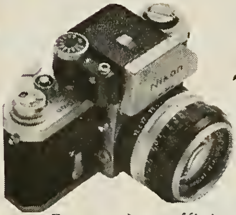
but we got up through the Gran Soela without incident, and spent the first night at a place called, in the Wayana language, Kudikudipupkatpa. On Friday, June 21, we continued south on the Litanie River. In the afternoon, we were surprised to see a boat being paddled downriver by a bearded Frenchman and three teen-age Wayana boys. The man was André Cognat, a Frenchman who had been living for many months among the Wayana Indians in the Gran Soela. Since he does not speak English, and we speak no French, we conversed with him in the Wayana language. He said that he had been up in the Waremapankreek and had seen the new Indians. As soon as he had heard the report of the first contact by the Wayana Indians, he had made his way up in order to get pictures and a story. It is rumored that this man is a teacher, but so far as we know, he is not doing any teaching. We do know that he is a journalist and writes for various French magazines, and he has written at least one book of his life among the Wayana Indians. At any rate, he warned us to be sure to secure our possessions as the Indians were terrible thieves. When he endeavoured to take their pictures, some of the Indians had become very alarmed and actually drew bows to shoot him. They were stopped by others of the tribe. We understand that they took his camera and smashed it. While he was in their camp, others doubled in behind him and smashed the front and the motor of his boat with their stone axes. He reported that they took all of his trade goods and one of his party's hammocks. At this point, his group decided to get out if they could, which they apparently did without further incident. We feel he was fortunate to have gotten out alive.

We made camp Friday evening on an island called by the Wayanas Isoli Atakima. By Saturday noon, we had made the mouth of the Waremapankreek. Two of the boats employed by the mapping project overtook us at this time. They were returning to the headwaters of the Warempankreek with fuel, etc., for the work project. One of the boats was carrying three of the men who had made the original contact with the strange Indians. We decided that we would proceed together and make our contact through these men. We arrived at the scene of the first contact at about 1:30 P.M., but there was no sign of life. We divided our party in order to leave some behind to guard the boats while the rest of us took the trail to their campsite. The bush was flooded due to extremely high water, and we waded through swamp above our waists for at least a half mile. Then we climbed over a high hill and descended into the adjacent valley. There was a strong smell of burned wood in the air even before the campsite came into view. The Indians in the lead shouted that the people were gone. This was a great disappointment to us. We walked into the deserted campsite and saw ample evidence that the people had left in a hurry. We surmised that they had deserted the camp about two days before our arrival. The ground was littered with hundreds of fishhooks, meters of fishline, beads, broken mirrors, red cloth, bags of salt, matches, and the barrel of the shotgun they had stolen from the first Wayanas that had seen them. It had been smashed with their stone axes. It appeared to us that the people had in some way been abused, and had expressed their anger by destroying the trade goods and gun. We were also sure that they did not understand the use of the trade items. We spent about two hours in the camp. It consisted of eight huts built under the trees on a dry piece of ground in the center of a swamp. The huts had shedlike, flat roofs, made from the leaf of the mumu palm, and pitched slightly to the side and rear. Posts were arranged so that hammocks could be hung in a triangle or a square with a fire in the center. Since they sleep in open hammocks the fires are necessary at night for warmth and to ward off bats, mosquitoes, and other insects. At the side of each hut was a fireplace made of three stones dug down into the ground. Beside each hut was a pile of palm fruit seeds, bones, and other debris. All the bones were cracked or crushed for the purpose of sucking out the marrow. An abundance of children's arrows and two small bows gave evidence of several small children in the camp. The Indians looked about for a trail, but since it was getting late, we left in order to make our camp or the night. We returned to the oats and drifted downstream lookng for a suitable place on the bank f the creek to construct hasty shelters for the night. The banks were ery steep and slippery from the requent rains. As we drifted we saw everal places along the bank where he Indians had fished. There were eaves placed on the damp ground n which they had sat while waiting or an aimara to rise to the bait susended on a vine. When the fish suraces for the bait, they shoot it with ow and arrow. We also saw a clear rail coming down from the hill. At he base of it, a tree about 12 inches n diameter had been felled across he stream. We saw where, at places long the length of the tree, poles ad been stuck down into the sand. cross these poles several vines had een tied for a handhold so that the eople could cross the swift-flowing, ooded creek.

The night was spent without incient except for heavy rains. Early unday morning, June 23, four of ne Trios and one Wayana returned o the camp of the strange Indians o look again for the trail by which ne people had left. We busied ourelves in camp and established radio ontact with mission personnel on ne coast, asking them to inform ceriin government officials that the reort had been verified but that the ndians had evacuated the area.

At 2:30 P.M., the scouting party eturned. The first comment we eard was from the Wayana, Tanni. He said, "Very happy I am." I sked, "Did you see the people?" He eplied, "yes." They then proceeded o tell us the whole story. At the riginal campsite they had discovred a trail going west through the wamp. They followed this trail for early an hour. It had been closed several places and efforts had been ade to confuse the trail. They were ble to figure it out and soon walked to another campsite exactly like the rst. It, too, was deserted. They conued on to the west, and near noon ame upon another camp, again just ke the other two. However, this one as inhabited. There was an elderly an, two old women, and several oung girls and children. Inkiman, ne of the Indians in our party, reeted the elderly man with "I have ome my friend." There was no anver. Then he said, "I am a good



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one. I am your tribesman." To this the old man slapped his chest and the back of his neck and said. "I am good. Are you a tiger that you smelled me out?" Inkiman replied, "No, I am not a tiger, I am your tribesman." It must be noted here that each one could not understand everything the other said. The language was close enough so that they could pick up a few words and anticipate the general context of the conversation. Then, too, being Indians and thinking much alike was also a great help. They talked and traded for about an hour. The old man said that they were very angry with outsiders. He told of how the other white man had treated them. He was, of course, referring to André Cognat. André had simply forced payment into their hands and had taken their monkey-teeth necklaces off their necks. He helped himself to their stone axes and a hammock, arrows, etc. He gave them payment, but never having seen such things, they had no idea how to use them. The old man said that they did not find it good having people take all of their possessions. They did not want to part with all of their monkey-teeth necklaces. So, they were moving west in order to get arrow cane to make arrows to kill others who might come in to molest them. The group had split. The younger men had gone on ahead, and this elderly man was coming along behind with the old women and children. He also told Inkiman that he had been watching all the movements of our expedition. He had seen us all approach his deserted campsite. Inkiman told him that the white people he had seen looking through his village were the Trios and Wayanas' teachers. He said that they were good ones, not greedy like the other white man had been. He said he wanted to bring his teachers in to see the old man. After a time, the old man agreed. He said that he would wait in this village until noon the next day. If we were not there by noon, then he would continue on his way west. They talked and traded a bit more and then the men from our party returned to our camp on the Waremapankreek. We spent the rest of Sunday reorganizing our gear and planning for the following day. (They had successfully stolen two of the Trios' machetes.)

The next day we were up by 5:00 A.M. For this initial contact, we decided to take in only our hammocks, cassava bread, and some gifts for the people. Again, we divided the party. We left two men behind with the boats and instructions to load all the supplies left behind and shove off downstream in the event of any trouble in our absence. Then we sent five Indians on ahead, for we did not think that we could make it to the contact village by the appointed time. These five men would go prepare the way for the rest of us who would come along with the women and supplies. There were thirteen in all that were to go in the actual contact party.

The Wama ax. Head is bound to 17-inch handle by palm fibers.

The first group was off on the trail by 7:00 A.M., and the rest of us got under way about 8:30. The trail was extremely rough. We climbed steep hills and stumbled over tangled roots hidden in deep mud. We passed through the first deserted village and pushed on to the second. In their second camp, we rested for fifteen minutes and then took to the trail once again. We were anticipating the contact in their third camp. It was about noon when we arrived there, and we were again keenly disappointed to discover that the people had moved out, not an hour before we arrived. The fires in several of the huts were still burning. As before, we saw discarded trade goods that the Frenchman had forced upon them. It was apparent that the old man was being very cautious and did not want us to come upon his little band, so he had moved them out ahead of us to overtake the other part of his group. A Trio and his wife were waiting at the campsite to tell us of the old man's departure and to lead us on. The rest of our advance party had moved on with the old man and his group. We took to e trail again after a few minutes of st, and for the next two and a half ours forced ourselves over the worst rt of the trail.

Along the way we passed wild fruit ees that they had cut down with eir stone axes to get the fruit. We w where they had placed leaves on e ground to sit on while fashioning ck carriers out of palm leaves. here was the skull of a tapir hanging a piece of vine in the trail. In an- her place we saw where they had nstructed an ingenious scaffold out 45 feet above the ground, so ey could extract honey from hives the trees. Built between three trees, formed a platform on which they uld stand and chop holes with their ne axes. Needless to say, all of ese things gave us a great thrill as realized we were walking in the il of Stone Age people and were out to come face to face with them. e had no doubt but that our lives re in danger, and we felt certain at our every move was being tched, even as we had been tched by unseen eyes on Saturday. e moved on, confident in our trust God; relying upon our years of perience with Indians, their culture d languages, and the wisdom of the dians in our party.

At about 3:00 P.M. on Monday, ne 24, 1968, we splashed across an- er swamp and approached a vil- e exactly like the other three that had passed through. There was a rmur of excited voices and wood oke hung heavy in the damp air. young man carrying a stout bow d several arrows came to the edge the camp to greet us. His appear- e was formidable. He was short d heavily muscled with skin almost ite and incredibly dirty. His hair— ck, bushy, and disheveled—was ed with mud, cut in crude bangs r the eyebrows and around to the s, and hung long at the back of the k. His eyes were a bit bulgy, and facial features on the heavy side. ound his waist he wore a number strings made of the hair of the ck spider monkey. Into this was ked a loincloth about one and a f inches wide, which was pulled htly through the crotch, between buttocks, and tucked under the ng in the back. The loincloth, de from the fiber of the *Mauritia* m, held the penis tightly up inst the abdomen, and the testicles

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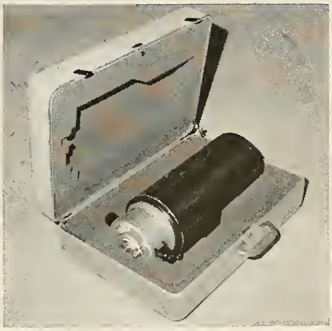

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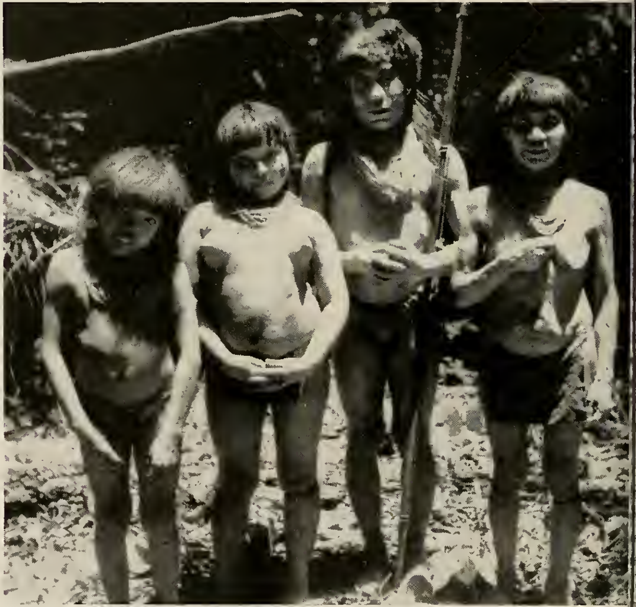
protruded on either side. Around the calf and ankle was a string of black spider monkey hair or that of the red howler monkey. His arms were heavily scarred from just below the biceps to midforearm. This is apparently done to increase their efficiency as hunters. The man was extremely nervous, and shifted rapidly from one foot to the other as we approached. The Trios had taught us several phrases to say to the people, so we greeted them with their own expressions punctuated with forceful slaps on the chest and back of the neck. He responded in the same way. We filed on by him to the center of the camp. The men were gathered there about their chief, and the women were watching quietly from the backs of their huts, trying to keep their children quiet and as much out of sight as possible. Inkiman was standing guard over the things that the advance party had brought in with them, and the others were hastily building huts for our party to hang hammocks in. The Indian men never put up their weapons, and appeared ready to use them. We knew that we would seem very odd to them, so



Face to face with the Wama. Recent photo shows, from left, a you
boy, a teen-age girl, a warrior, and the wife of the chief.

those of us that wear eyeglasses ha
removed them along the trail and r
frained from wearing them all th
time that we were with these peopl
We had also hidden our wristwatche
Here, in the camp's center, we agai
went through many explosive gree
ings. The people felt our skin, pulle
the hair on our arms and chests, en
deavored to look under the women
skirts, and tried desperately to ste
our machetes, bows and arrow
knives, etc. They kept saying th
they wanted to see the possessio
that we had brought along, but Ink
man told them to wait until our hu
were completed and we had hung o
hammocks. He had to repeat th
every few minutes, for the peop
were very impatient and restle
They kept moving from place
place, returning every few minu
to pull on the strings of our packs.

Soon the huts were finished, t
Indian women in our party had hu
all of our hammocks, and we h
tied all our personal possessions
side them. Then all gathered arou
as we opened the pack containing t
gifts. Inkiman distributed machet
axes, knives, files, and matches.

owed them how to use the file for
arpening the tools. and one man
came so excited that he hit himself
the head with the file instead of his
nd as is their custom. Each disap-
ared into the bush with his new
ssession. It was apparent that they
al from each other. as well as from
angers, for they kept going in
ery direction into the bush to hide
retrieve some possession for trade.
We tried in many ways to find out
o these people are. but they evaded
estions and refused to name them-
ves. They referred to us by rela-
nship terms, and asked that we do
same. So we still do not know
at tribe these survivors represent:
rhaps Wayarekule, perhaps Wama.
rhaps some other unknown group.
ey told us there was another group
their relatives, consisting of ten
n, plus women and children, off
the west. If that is the case, there
ld be as many as sixty or seventy
them still surviving. In this group,
re were eight men. eight women
twelve children. The oldest man
s perhaps forty years of age. The
er seven were in their late teens
early twenties. Among the
men, there were two elderly
ies; the other six were in their late
ns and twenties. The twelve chil-
n ranged in age from infants to
ut ten years of age.
The chief told us of another group
fierce Indians, to the southwest,
om they call the Maladiyaima, or
Leaf people. He said they fear
m and advised us not to go into
ir territory.
The women became bolder and
ne out of their huts, eyeing us cur-
sly. For the most part, they busied
mselves with their children,
ked wild pigs, and foraged for
wood. We were amazed to watch a
y smashing a dead tree into little
ces of firewood with a heavy club.
women were short, well fleshed,
had attractive facial features.
y were dressed only in an apron
eeds, $5\frac{1}{2}$ by $7\frac{1}{3}$ inches. Like the
n, they gave no indication of ever
hing, for their bodies were very
y and they continually scratched
their hair. They carried their
ies on their backs in a sling made
m the bark of a tree and suspended
m their heads. They wore neck-
s made from the teeth of the red
ler monkey, and other smaller
nkeys, interspersed with the same

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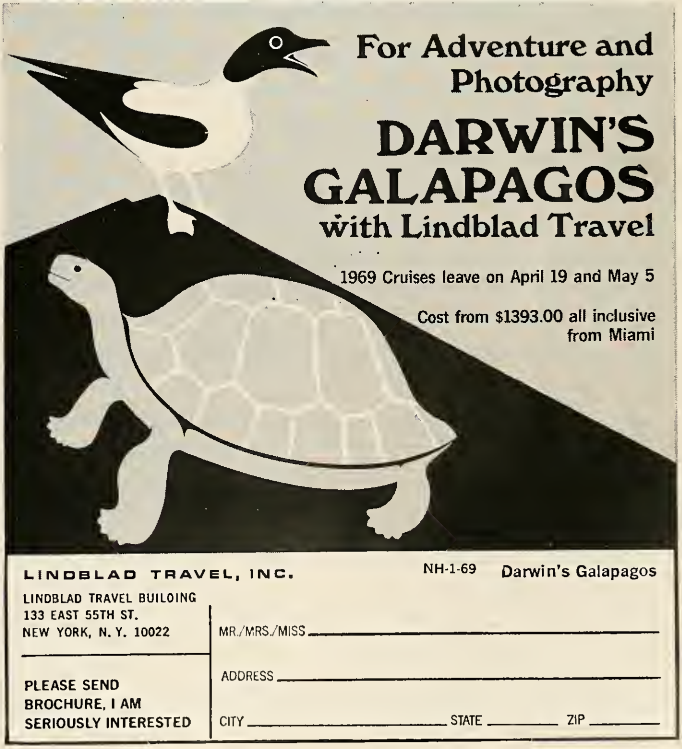
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type of seeds that their aprons were made of. The only items we saw in their possession, other than the things André had given them, that gave any indication of their having had a previous contact with manufactured items were the blade of a small pocketknife tied by a string around the neck of one of the men; three other knives about three inches long made from scraps of steel, sharpened on a stone and hung about their necks; and a discarded five-gallon oil can in which one of the ladies was cooking a wild pig the men had killed that day. No doubt they had rummaged about the camps of other expeditions and had picked up these things.

The bows that the men carried are about 6⅓ feet long, well turned, and smoothed with a boar's tooth tool. The bowstrings were made from the fibers of the *Mauritia* palm. They displayed arrows of several types. Some had long bamboo tips and others were made of bone. They use curare poison, as do the Trio Indians, and carry the poisoned tips in a bamboo container slung about their necks. They know of a place to the west, perhaps in the Oelemarie River area, where arrow cane grows in abundance. It is there the people intended to go as soon as we left.

We told them that we would like to stay for several days with them, but they replied that we should leave in the morning. They said it was good that we had talked, good that we had traded, but they were not accustomed to us and wanted us to leave in the morning. They seemed determined to go after the arrow cane: several times they said they were short of arrows and wanted to be prepared for others that might come to molest them. They did say that they would be back again in this area and that we should come back another time. They said that if we came as we did, speaking their language, they would not be fierce.

At dusk the Trios called all the people together, and we sat on the ground while the Trios sang a number of songs. The people listened with interest and asked the meaning of the songs. They became excited when we produced a tape recorder to try to get some of their sound on tape. As long as the microphone was not in sight they were not disturbed, but as soon as it was extended on its cord they became highly agitated and insisted that we hide it, which we did. For this same reason we did not endeavor to get any pictures. The wisest course was to proceed cautiously and slowly, not introducing too many new things and concepts in this first meeting. About this time a strong wind and rain came up. The huts were built under the trees and rotted branches began falling all about, so everyone went to his hut until the rain ended.

After the rain had passed the men called us to eat. We took this as a good sign and shared the boiled wild pig. They have no seasoning of any kind but they had cooked the meat until it was tender. The cooked meat was heaped on a canoe-shaped palm nut pod. The men tore off chunks of the meat and passed it around to us, the other villagers, and children. We dipped cassava bread in the broth, but it was not very flavorful. We offered cassava bread to the people, but they were afraid to eat it. The old man slipped his piece under him and sat on it. Inkiman told him that it was food, but he said, no, it was good for a seat. Others smelled of the bananas and sugar cane that we offered them and then threw them away. As far as we could determine, in the short time that we were with the people, their only foods are meat, fish, bush fruits, several kinds of palm nuts—which they eat and from which they also make a drink—honey, and the heart of the *Mauritia* palm. All the time that we were there, there was the thumping of stone axes against the palm nuts. Someone was eating continually. In every hut in this camp, as well as in the other three camps through which we had come, we saw small flat stones specifically for the purpose of having a solid surface on which to crack nuts. In all of the huts, we could see small baskets full of nuts. Several of the men brought out their little baskets for us to see their meager possessions. These contained a quantity of nuts; the lower jaw of a wild pig, which they use for shaping their bows; odds and ends of string; a few bone tools; a tiny comb made from sharpened sticks mounted in a piece of arrow cane; and a tool made by embedding a rodent's tooth into the end of a stick. This and a deer's horn are apparently used for gouging out the holes in the handles of their axes to receive the stone head.

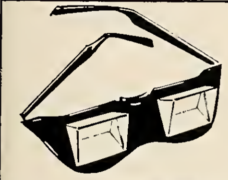
The stone axes were very interesting. We saw many of them, ranging in size from very small ones to ston weighing more than a kilo. The ha dles are crudely cut and only lon enough to be held in one hand. O end is very large with a hole gouge into it into which the head is fitted. I some cases the hole was cut too larg and they padded it with string mad from palm fibers and the sap of th rubber tree. Then the end was tie with string to keep it from being spl by the blows. With few exception the stones were extremely crude an not very well sharpened. They carr their axes in the loincloth string i the small of the back. The only thin that they make that shows a grea amount of skill are the bows. Thei pottery is thick, heavy, and not ver symmetrical, and bears no design a all. Their combs and fans are als crudely done compared to those o the Trio or Wayana Indians.

We showed them our flashlights but they became very alarmed an told us to put them away. Darknes descended and by mutual agreemen we all retired to our hammocks. The had made an agreement with ou Indians that none of us would leav the huts during the night. They, b the same token, would remain i theirs. One of the men took a sapling split the end, and wedged into it large chunk of resin. He stuck th other end into the ground, and ig nited the resin, which gave a goo light and burned for quite some time Fires were kept ablaze in every hut and they sat about their fires o lounged in their hammocks keeping their eyes turned upon us. We wer so crowded in our huts that it wa impossible to stretch out in our ham mocks, so we rested as best we could but no one slept during the night. W did not dare to put up our hammock covers. This was, without doubt, th quietest Indian village we had eve spent the night in.

The only pets we saw in the village were four half-grown wild turkeys which followed their owner whereve she went. The Indians had instructed us not to touch them. There was n sign of any sickness among the peo ple, no coughing, and only a few sores on their bodies. They were however, covered with insect bites Everyone had a hammock, and w noticed that some individuals had two or three. They were made o string spun from the fibers of th

Continued on page 6

haverhill's



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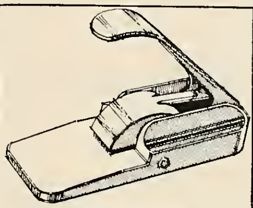

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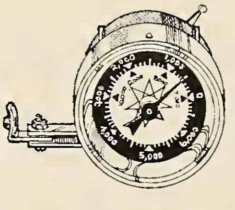

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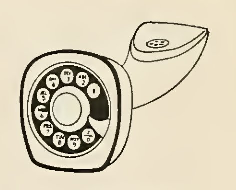

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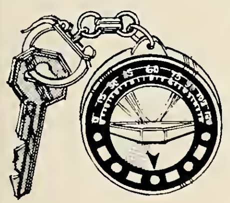

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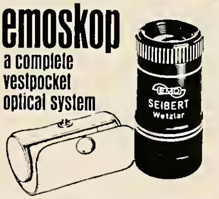

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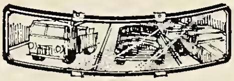

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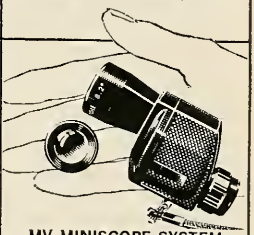

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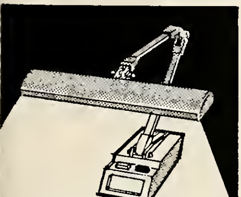

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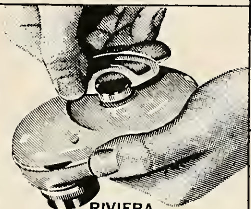

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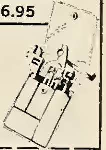

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Getting Through Winter

by Marston Bates

January—a new year, but also midwinter, with February and March yet to come. The ancient Romans began the year with March, which seems more sensible because the weather, at least, was bound to improve. Spring is always hopeful, but I am not so sure about January except for winter-sports enthusiasts.

Yet there is no denying the fascination of winter from the point of view of natural history. Animals, plants, and people all face the problem of getting through winter—of finding some way of surviving in the unfavorable cold and of coping with the earth's blanket of snow. The curious thing is that from the point of view of geologic history this seems to be a relatively new problem. Given the tilt of the planet's axis and the nature of its orbit around the sun, the present zonation of climates seems understandable, even inevitable. Yet the geologic evidence all indicates that through most of its history the earth has had a genial climate, even at high latitudes, with less marked seasonal changes than those we know.

There seems to be no generally accepted explanation for the climatic changes of the geologic past—perhaps there is no single or simple explanation. There is evidence that the magnetic poles have not always had their present position; if the geographical poles also shifted there might well be a great change in climate. If the North Pole were in the north Pacific and the South Pole in the south Atlantic, ocean currents could well prevent the polar accumulation of year-round ice. With the poles in their present position—one over the enclosed Arctic Ocean and the other over the Antarctic continent—the dispersal of cold is limited and ice accumulates in the polar regions.

During the long period when modern forms of life were evolving, permanent ice was probably not present on our planet. The fossil vegetation shows that most of the area covered by the United States had a tropical or subtropical climate. To the north, the region now covered by the coniferous forest of the taiga shows a temperate flora comparable with that of the eastern United States now, and Antarctica was similarly covered.

Then came the Pleistocene—the Ice Age—with repeated glacial advances and retreats and great fluctuations of climate, at least in high latitudes. What caused these? There is no evidence for polar shifts during this period, although there may well have been changes in atmospheric and ocean circulation. Were the glaciations due to changes in the intensity of solar radiation? Or to changes in the carbon dioxide content of the atmosphere? Carbon dioxide has a "greenhouse effect," warming the earth's surface by reducing heat loss through radiation outward. Whatever the cause, the effect is clear: the repeated massive accumulations of glacial ice. Geologists are apt to term the time in which we now live as "Recent," dating this from the beginning of the last glacial retreat. But during January it seems obvious enough to me that we are still living in the Pleistocene—which makes for problems.

Most birds solve the winter problem by migrating to some region with a more sensible climate—as do people who can afford to live a double life. With birds the need to migrate is apparently due more to lack of food than to unfavorable temperature in itself. After all, quite a few birds do manage to stick through the winter if their food habits allow it. Owls continue to harry the local rodents all year round; crossbills live by their expert dissection of pine cones; grouse, by eating things like spruce buds. But birds that live on insects and berries have a hard time: not only is the food scarce and difficult to find but also the daylight hours available for searching become very limited.

I have sometimes wondered why migrating birds bother to come north in the spring, why they don't just stay in the more congenial tropics. The answer, again, lies in the food supply: they can take advantage of the rich possibilities and productivity of the northern summer for raising their broods without the competition so prevalent in the tropics. But how did these often complex patterns of movement get started? And why don't some individuals remain, instead of making the long trek north? The migrating instinct has been broken in the opposite direction; a considerable variety of migrants have been known to stay through the winter, supported by bird-loving humans who provide seed- and suet-stocked feeding stations.

Long-distance migration depends on flight, which means that mammals (except bats) must find other solutions to the winter problem. To be sure, a number of mammals change habitats with the seasons: caribou migrating from the tundra into the wooded taiga where they can dig for fodder in the softer snow; and mountain sheep moving to lower

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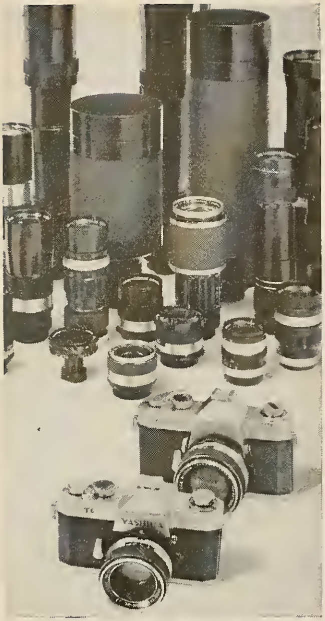

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slopes. But such movements are hardly comparable to the journeys of the birds. Mammals, then, must either carry on as usual during the winter months (the weasel solution), store up food reserves (the squirrel solution), or suspend activities—hibernate (the woodchuck solution).

True hibernation in a mammal involves a considerable drop in body temperature and a slowing of all metabolic processes, including respiration and heart rate. This is the case with woodchucks, hamsters, and hedgehogs in their burrows, and with bats congregated in caves. Bears do not hibernate in this sense, although they may hole up and sleep for most of the winter, living on accumulated fat. Fred Bruemmer has given a nice account of the winter behavior of the polar bear in the issue of this magazine for October, 1968.

Snow, from the animal point of view, can be a nuisance, by covering up food; or a blessing, providing a snug refuge. Snow is an excellent insulator, and the temperature under a couple of feet of snow cover rarely drops below 20° F., even though the air above gets down to 50° or 60° below zero. Small mammals like voles and lemmings are active all winter in their runways and nests under the snow, living on roots, vegetation, or stored seeds. It is a dark, silent world under the snow, and the animals there are even protected from many of their usual predators. Sometimes, though, they have to construct ventilating shafts because of the accumulating carbon dioxide, and they risk getting picked up by passing owls at the openings of these shafts.

The smallest mammals have to retreat under the snow in order to maintain body temperature. The smaller the animal, the greater the surface area in relation to body mass: since heat is lost through the surface, a mouse simply cannot keep up its body temperature in a very cold environment. Squirrels are about the smallest animals that can keep active in the open, and the red squirrel of the north retreats beneath the snow when the temperature reaches the neighborhood of 25° below zero Fahrenheit.

Mammals and birds are "warm-blooded." In other words they have some means of keeping their body temperatures fairly steady despite fluctuations in the world outside. Reptiles, amphibians, fish, and insects are "cold-blooded." They have a certain amount of control over body temperature by means of behavior: they can warm up by sunning themselves or cool off by getting into the shade. But it is difficult for such animals to keep warm in winter. The chemistry of life depends on water in a liquid state; if the bod actually freezes, if ice crystals are formed in the cells, the system breaks down and the animal dies.

In the north, therefore, cold-blooded animals must either fin some place to pass the winter wher temperatures do not reach the freezing point or develop a special resting stage in which the water content o the protoplasm is greatly reduced s that its freezing point is lower tha usual. Fishes and other aquatic animals are able to keep active in th winter in water under the ice, whic is usually a few degrees above th freezing point: terrestrial animal frequently dig into the soil.

Amphibians and reptiles have no been notably successful in adaptin to the winters of high latitudes Charles Walker, the curator of her petology at the University Museun here, tells me that there are 13 species of frogs in Costa Rica, 12 i Michigan, but only 2 in Alaska—an there is an equally dramatic drop i the numbers of snakes and lizard

Insects have developed a particu larly wide variety of ways of su viving winter. They may hibernate a adults, pupae, larvae, or eggs. I hav no statistics, but I suspect that th winter is most commonly passed i the egg stage. Whatever the form c hibernation, there must be som mechanism for starting the quiescen period before killing temperature have arrived, and for avoiding pr mature resumption of activity b cause of an unseasonable warm spe during the winter. A common solu tion of these problems is "diapause, a periodic suspension of activit more or less independent of extern environmental conditions.

My own experience with diapaus has been with mosquitoes. It ma occur in these insects in the egg, la val, or adult stage, depending on th species. The common European ve tor of malaria, *Anopheles macul pennis*, hibernates as an adult, ar arge numbers can be found in stables nd outbuildings all through the winer, their abdomens distended with at bodies instead of with eggs. Since nosquitoes usually convert blood nto eggs, what causes the prehiberating individuals to make fat intead? I could not find any single enironmental factor, such as light or mperature. If, however, the mosquioes were kept under conditions in hich they tended to stay quiet rather nan fly about, they would accumuate fat; if they were stimulated to aily activity, the fat would be bsorbed and eggs formed with the ext blood meal. I came to the conlusion that the nature of conditions n September—somewhat lower temeratures, shortened twilight period, requent rains—led to inactivity and ence to fat formation, well before he rigors of winter set in.

Most mosquitoes spend the winter or in the tropics, the dry season) in ne egg stage, hatching with the onset f spring (or of the rains). Many udies have been made of the kinds stimuli that can break the diapause nd cause the eggs to hatch. In eneral, the eggs have to be dried and en moistened; with some mosquies this is enough. With others, the ggs will not hatch if submerged in ain water, but will if placed in an fusion of dead leaves or similar ganic matter. In some cases all eggs ill hatch if exposed to the right imulus; in others, only a few of the ggs will hatch at the time of any rticular treatment. It reminds me ry much of the complex factors that overn the germination of seeds, and has, of course, the same object: to sure that all individuals will not be lled as a consequence of some cliatic accident.

Most groups of animals and plants e much more abundant in the opics than in high latitudes. There s been much speculation as to the use of this. If strong seasonal anges date only from the beginning the Pleistocene, a couple of million ars ago, maybe there has not been ne for evolution to develop winter aptations in more species. It seems ore likely that the so-called Temrate Zone is simply not as favorle to a diversity of species as are e tropics. Winter, in the earth's hisy, is simply a temporary aberran; but we are stuck with it and ght as well adapt as best we can.

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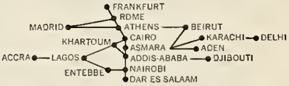

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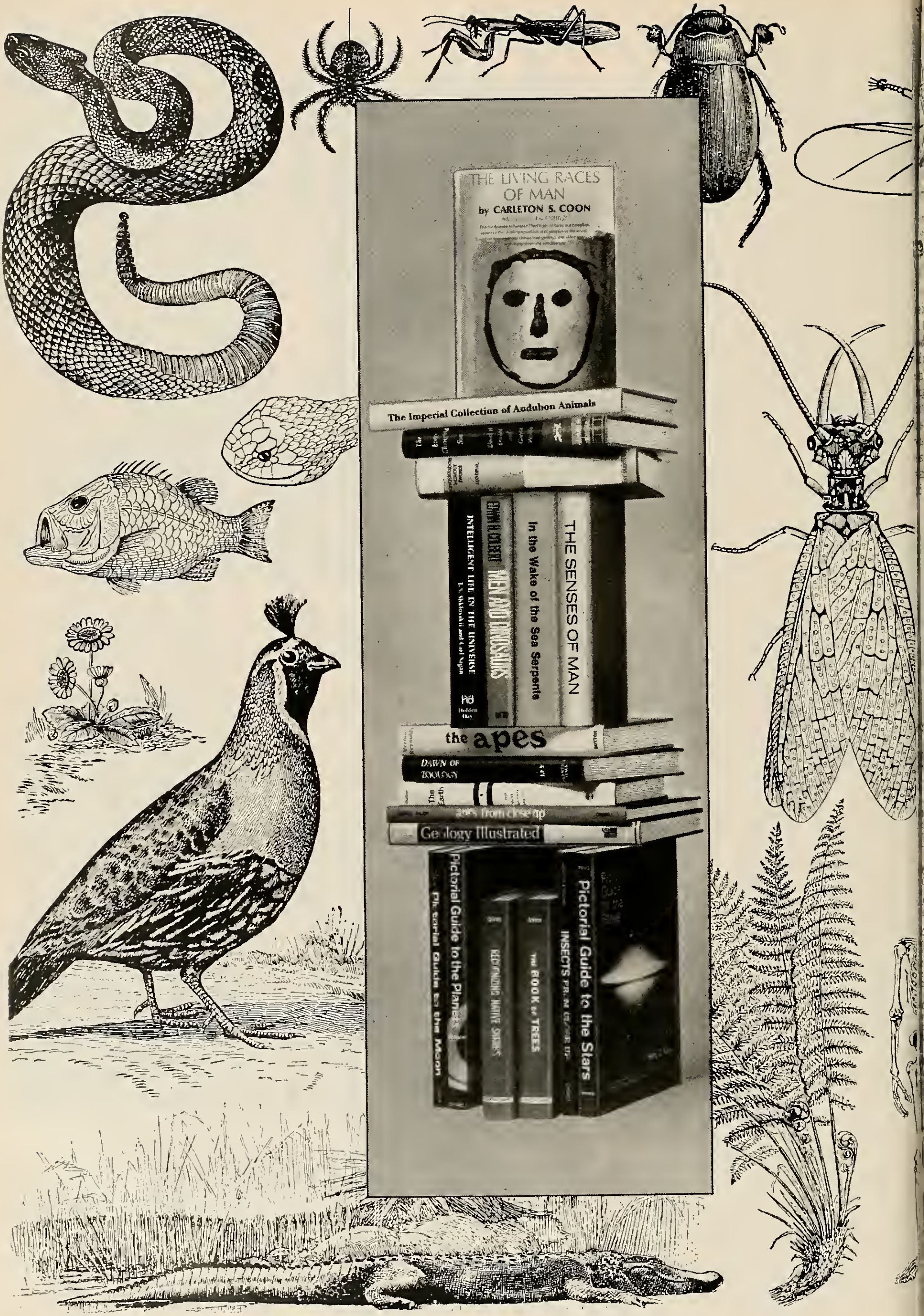
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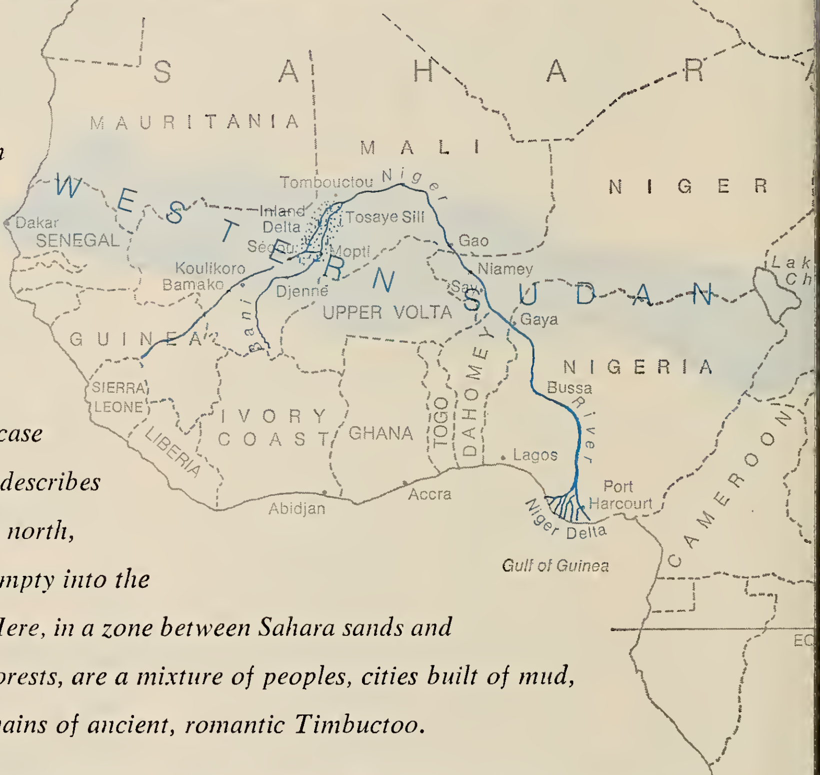
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Far inland from West Africa's showcase cities, the Niger describes a great bend to the north, then turns south to empty into the Gulf of Guinea. Here, in a zone between Sahara sands and tropical forests, are a mixture of peoples, cities built of mud, and the remains of ancient, romantic Timbuctoo.

The Niger, Africa's third longest river, originates in the highlands of Guinea, only some 150 miles from the sea. In what seems an anomaly of nature, it then flows 2,600 miles to reach the sea by way of a broad semicircle to the north. For much of its length, the Niger lies well within the interior of West Africa, cut off from the coast by dense tropical forests to the south and by the Sahara to the north. Not until about 125 years ago was much known about the middle section of the river, the broad half-circle known as the Great Bend of the Niger.

Here, far from Abidjan, Accra, and Lagos—the showcase capitals of West Africa—much of the population lives as it has for centuries: farming, herding, and fishing. An interest in the people and the land, and the changes taking place in both, led us some 1,500 miles down the broad curve of the Niger through the republics of Mali and Niger—a fascinating and often bewildering experience. Technical advances are occurring, but slowly, perhaps more slowly than elsewhere in Africa. Almost at the edges of the modern towns, one can find people living totally within the framework of traditional tribal societies.

Geographically the Niger bend lies at the edge of the desert, within the broad sub-Saharan belt often referred to as the Sudan, which runs eastward from the coast of Mauritania and Senegal through Lake Chad to the Nile. The name "Sudan" is somewhat confusing, because it is also the name of the republic south of Egypt (as Niger is also the name of the republic above Nigeria). The term actually comes from the Arabic *Bilad-es-Sudan* ("Land of the Negroes") and in West Africa properly refers to all the area south of the Sahara. To prevent confusion, "western Sudan" is used here to mean the part of West Africa between the forest and the desert.

In this region there are few physical features to serve as boundaries between geographical divisions, which are based on the effects of climate upon vegetation. Much of the western Sudan, including the Niger bend, can be described as *sahel*

A vendor displays his wares on a ferry that crosses the Niger.

NIGER RIVER

Rothmans
KING SIZE
BEST TOBACCO
MONEY CAN BUY
GIANT STRENGTH
OMO

—semiarid regions where the annual rainfall ranges from 8 inches at the northern boundary to about 30 inches at the southern one, and where the vegetation is more continuous and diverse than in the true desert. As in all subdesert regions, plant life in the *sahel* has a precarious hold on the soil, and desert conditions may return where the land has been overgrazed or the bush cleared. There are also indications that climatic changes have caused the limits of the Sahara to shift significant distances both north and south during the past two million years. Fixed dune fields indicate that desert conditions once prevailed much farther to the south than they do now; lake deposits and strand lines show that at other times more humid conditions existed much farther to the north than they do at present.

In general the *sahel* landscape is one of slight relief: low-lying, fixed dunes and slight escarpments covered by a variety of grasses, including the *cram-cram* with its prickly seeds, and occasional trees, notably acacias. The monotony is broken only by the rivers and their green-fringed banks.

Historically, West Africa is perhaps best-known for the great empires—Ghana, Sosso, Mali, Songhai—that arose and flourished during the Middle Ages. Their success came

Zebu cattle, right, are herded past village in Niger River's inland delta region; below left, youngsters play near Tombouctou, where the Niger sweeps eastward.

from an ability to control trade between the Mediterran
and the forested coastal regions to the south. As the histo
"highway of West Africa," the Niger was one of the
geographical factors that gave the Sudan a unique posi
for this control. The other was the Sahara—"the desert s

Although both the Greeks and the Romans previously
some contact with the Sudan, it was not until after the in
duction of the camel into North Africa, about A.D. 300,

travel across the desert was greatly facilitated. The S
Negroes could provide themselves with most of the necess
of life; the one significant exception was salt. The N
African Berbers, who controlled the Sahara's salt dep
began to exchange this commodity for gold and slaves
the southern regions. In time this trade expanded. Bes
slaves and gold, the south began to supply kola nuts
ivory, while cloth, copper, beads, and cowrie shells (
used as currency in the Sudan, even as late as 1945),
added to the salt provided by the Berbers. Along the sout
edge of the desert, trading centers began to be built
cities such as Ghana, Mali, Djenné, Gao, and Tombou
(this is now its official name, although many refere

nue to spell it as Timbuktu, Timbuctu, or Timbuctoo). ɔntact between the North Africans and the western nese did not remain purely commercial. Berbers and ɪs were soon migrating to the southern edge of the ːt, at first perhaps principally to raid for Negro slaves. r, migrations advanced and declined in response to politi- hanges in the north. Between the fourth and nineteenth ɪries the history of West Africa is that of the rise and f the great Sudanese empires, controlled sometimes by 'orth Africans, sometimes by the Sudanese themselves. ′where the characteristics of the natives were modified ntact with the intruders. The sub-Sahara became a tran- zone ethnologically as well as geographically. In time ːame impossible to distinguish any pure racial types. y, pure-blooded Negroes are more likely to be found in ɪrest farther south, where foreigners rarely intruded be- of transportation difficulties and disease.

In Tombouctou a woman removes baked bread from an outdoor oven made of mud, above. At left: beyond Mopti one can see the camps of Bozo fishermen.

ate foreign influence on the people of the Sudan came France. Contact, mainly along the coast of West Africa, nade through trading companies set up in the seven- ɪ century to compete in the slave trade. With the suppression of slaving, Europeans turned to other sources of African profit, and a scramble for power began. By the end of the nineteenth century most of the western Sahara was under French control; and the areas that are now Mali and Niger became part of the former French colonial federation, Afrique Occidentale Française (A.O.F.). This explains why French (of some sort) is the lingua franca, and French cooking (to our delight) is not unknown.

The Niger enters the *sahel* zone near Mali's capital city of Bamako, and it was here we began our journey. Reputedly the site of the ancient capital of the Mali Empire, Bamako was merely a small village until the French established a military post there in 1883. Today it is a well laid-out city, its wide streets lined with mud and concrete buildings. A newcomer to Africa finds this city's sights and smells endlessly strange and exciting. And because it is an administrative and commercial center, it bustles with activity, ranging from the daily trading in the large open markets to the twice-weekly arrival and departure of the train from and to Dakar. Beyond Bamako the railway runs another forty miles to Koulikoro, its terminal; downstream from Koulikoro the Niger is navigable and travelers can continue inland by steamer.

Most of the peoples of Mali are represented in the popu-
on of Bamako. The full-faced, gentle Bambara make up
majority; Malinke, Diula, Sarakolle, Bozo, Dogon, and
ani comprise most of the remainder. One reason for such
al variety is the attraction that Bamako holds for Mali's
ng people—immigrants between the ages of 15 and 30
ount for a large percentage of the city's population. Most
he women wear the native two-piece long dress (although
n here in the capital some go topless) with matching high
oan, usually made of vivid prints or brightly colored solids.
s colorful are the long, flowing, open-sided *bubus* of the
n. Their taste runs more to subtle stripes and pastels. The
us are worn over either native or Western suits.

xcept in the European restaurants, where food can be
orate and expensive, meals are still based on rice and
et. Couscous, a dish traditional in much of North and
t Africa, is made here with millet and served with tomato
e (for special occasions, fish or chicken may be added).
mixed by hand and eaten with the fingers from a com-
bowl.

t Bamako the Niger scarcely lives up to any romantic
ept. Here, crossed by the only bridge in all of Mali, it is
more than a shallow channeled stream, and it is hard
alize that this is one of the great rivers of Africa.

he first mention of a large stream draining the country
h of the Sahara goes back to Herodotus, in the fifth cen-
B.C. Much later, in the sixteenth century, Leo Africanus,
anish Moor, erroneously described the Niger as flowing
; he also stated that one could travel by this river from
udan to Cairo. In 1796, Mungo Park, a Scottish doctor
ling for the African Association, reached the Niger at
u, and reported that it actually flowed west to east. This
European geographers to conclude that it must flow into
inland lake or swamp.

n a second expedition, in 1805, Park sailed downriver
anoe from Bamako to Bussa, only 500 miles from the
's mouth, where he drowned in the rapids. Not until
, when Richard and John Lander sailed from Bussa to
ulf of Guinea, was the problem of the Niger's course
y solved.

now remained for geographers and geologists to explain
eculiarity of the Niger's course, its long semicircular route
sea. In 1909, René Chudeau provided a basic hypothe-
le suggested that the present Niger was formed by the
g of two shorter rivers. The more western one arose in
uinean Highlands, fed an inland lake near Tombouctou,
t times flowed farther northward to drain into depres-
of the southern Sahara. The eastern river ran in roughly
pposite direction, from the Sahara to the sea. In 1968,
nglishmen, A. T. Grove and A. Warren, offered a more
ed explanation of events, beginning in the Pleistocene.
e western river, which drained into the southern Sahara,
d and supplied several lakes there. But when the climate
ne drier, in the Middle or Late Pleistocene, it is as-
l that the river stopped flowing beyond Ségou. Then, between 7,000 and 20,000 years ago, conditions became more humid and the river again pushed toward the Sahara. However, it found its former course blocked by dunes that had formed in the old lake beds. The river now established a new route farther to the east. Advancing eastward from Tombouctou, its waters eventually crossed the Tosaye sill and were "captured" by the eastern river. The result is essentially the single river shown on today's maps. The curved portion between what is now this upper and lower course of the Niger is called the Bend of the Niger.

n ancient times, camel caravan at Tombouctou
ts loading for trip back into the Sahara Desert.

But the joining did not result in complete stability for the river. Dry conditions returned, the waters probably stopped flowing beyond Mopti, and another system of dunes formed where the river had run. In a succeeding humid period a clay plain formed north of Mopti and deltas were built into a large lake, of which the present Lake Debo is the last remnant. The result of all this is that the present Niger has two deltas. One is located conventionally at the mouth of the river, near Port Harcourt. The other is the inland delta, in the area between Ségou and Tombouctou. In this swampy region the Niger flows through a maze of braided channels before becoming a single stream again, below Tombouctou.

The inland delta is partly responsible for the curious discharge pattern of the Niger. The peak high-water level on the Lower Niger, the result of local rains, is reached in October. The flow then falls off until December. From December until March the river is maintained by a flow from the rainfall of the previous summer in the Guinean highlands, which has been retarded by passage through the inland delta.

The rich deposits of sediments in the Niger's inland delta region have encouraged ambitious agricultural schemes during the present century. For example, in 1946 a dam was completed near Sansanding, 190 miles downstream from Bamako. It was hoped that by raising the river level 5,000 square miles of potentially rich land could be irrigated for the growing of cotton for the French textile industry. Today, after twenty years and an investment of 90 million dollars, only about one-fifth of this area is under cultivation—growing mostly rice because the climate proved less favorable for cotton. Other irrigation projects, closer to the Niger's mainstream, have been more successful. An example is on the mud plain near Mopti. Here, where the Bani River joins the Niger, several thousand acres of rice, millet, and other crops are under cultivation.

Mopti itself, a provincial capital of perhaps 15,000 inhabitants, is a charming town, in many ways typical of Mali. Because it is built on three islands connected by causeways, it is proclaimed by tourist officials as the "Venice of Mali." Actually, it deserves more attention for its architecture—a pleasing blend of Moorish and native styles, sometimes called *soudanais*. There is also a lively market and an active port, where shallow canoes, called pirogues, load and unload goods.

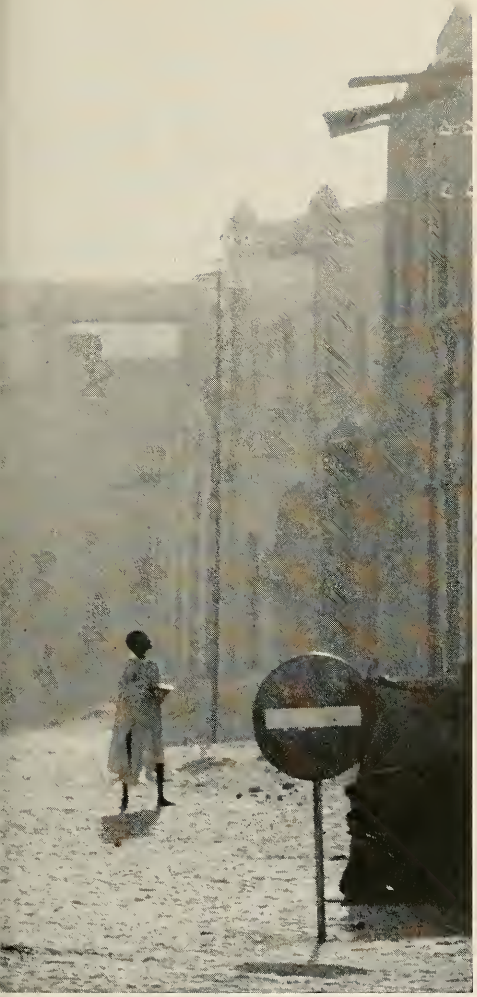
The 250-mile stretch of river between Mopti and Tombouctou is perhaps the most exotic part of the Niger's course. In a relatively low-water month such as March it can also be hazardous for the large river steamers, which must here thread their way through the braided, shallow channels. This

is the inland delta of the Niger, with its seasonally flooded distributary system of channels, which separate and rejoin. The low gradient, typical of deltaic regions, is responsible for the braided stream pattern. Also, typically, here the water flows a little above the general level of the plain, because of natural levees built up along the banks during flood season. Happily this makes it easier for ship's passengers to view the countryside.

The riverboats that are skillfully guided in and out of the channels often come close to the green banks and sandbars where the Bozo fishermen and Fulani herders have established their camps. Fishing activity increases as the season becomes drier. Even now the skeletons of half-emerged frame huts, which would be refurbished and used wher
level of the river dropped farther, were visible. The Fu
continually on the move to find pasturage for their
cattle often drive large herds across the river, adding t
uncertainties of navigation.

In places the greenness along the banks disappears
scrub growth and desert fringe the river's edge. Small vill
appear from time to time, all looking very much alike
hardly distinguishable from the desert around them.
are usually conglomerations of low mud houses surroun
a larger and more prominent mud structure—the mos
Curious wooden supports project from the larger buildi
these serve to make repairs easier when, inevitably, pa
the mud walls are washed away during the rainy seaso

Elsewhere, steamers pass through the great swamp
the Niger Delta—habitat for a multitude of wildlife, not



birds. For birds as well as humans, movement is dependent upon the rise and fall of water level. In March one sees mostly the native herons and pelicans, along with numerous smaller species. In fall and winter, great flocks of migrant ducks and waders arrive from as far away as northern Europe and Asia.

In addition to the constantly changing scenery, activities on the steamer itself are absorbing. Looking down on its open lower deck provides all the fascination of watching a lively African village. Here, large families, as well as traveling merchants, camp with all the paraphernalia necessary to their existence—beds, pots and pans, livestock, and the inevitable Arab tea service, usually of elegant quality and design and obviously the pride of its owner. One can see mothers washing their children, women preparing and cooking meals on glowing braziers, and men sitting in small groups, conversing, smoking, and drinking tea.

Arrival at a port is a signal not only for loading and unloading passengers and goods, but for buying and selling foodstuffs. Since these deck passengers are not served meals, they must buy daily what they need. In the ports where, because of low water-level, the boat does not dock but remains some distance from shore, the provisions come from a floating market. The local merchants, including women and children, either row out with goods in their pirogues or wade out with their merchandise on their heads. In either case lively bargaining—for chickens, fresh milk, bread, fruits, and vegetables—begins. Finally, when the warning whistle blows and the boat begins to pull away, frantic last-minute bargains are struck, and the lucky merchants who have disposed of their produce retreat to shore, jubilantly waving their handfuls of franc notes.

Two days' travel brings the steamer to the delta's northern

Though cars are few in Tombouctou and pedestrians monopolize this principal street, the city has erected this one-way traffic sign. Below: A boatman poles his pirogue (shallow canoe) on the river above Tombouctou.

edge, to Tombouctou, where the Niger turns eastward to continue its journey around the great bend.

More than any other city of the Sudan, Tombouctou long held a fascination for explorers. Perhaps the name itself makes it sound remote and mysterious, for even today, long after the actual mystery has disappeared, this mud city—only a little larger than other mud cities along the Niger—retains something of the legend. René Caillié, the first European to bring back a detailed description of this capital of the Sudan, described his arrival in 1827:

"At length, we arrived safely at Timbuctu. . . . On entering this mysterious city, which is an object of curiosity and research to the civilized nations of Europe, I experienced an indescribable satisfaction. . . . I looked around and found that the sight before me did not answer my expectations. I had formed a totally different idea of the grandeur and wealth of Timbuctu. The city represented at first view nothing but a mass of ill-looking houses, built of earth. . . . Still, though I cannot account for the impression, there was something imposing in the aspect of a great city, raised in the midst of sands, and the difficulties surmounted by its founders cannot fail to excite admiration. . . ."

This serves as a good description even today. One's principal feeling is that nothing has changed—except the size. In its heyday, the city may have had twenty thousand inhabitants; Caillié found an estimated ten to twelve thousand; today the figure is somewhere between five and seven thousand. We know that Tombouctou began sometime during the eleventh century as little more than a seasonal camp of the Tuareg. It soon became a crossroads for travelers, permanent residences were set up, and a commercial center was born. The city's growth has been attributed to three factors: its position in an area where the Niger reaches the desert; its location beyond the area of the river's flooding (making it open to land traffic throughout the year); and the political and commercial importance of the area to the west.

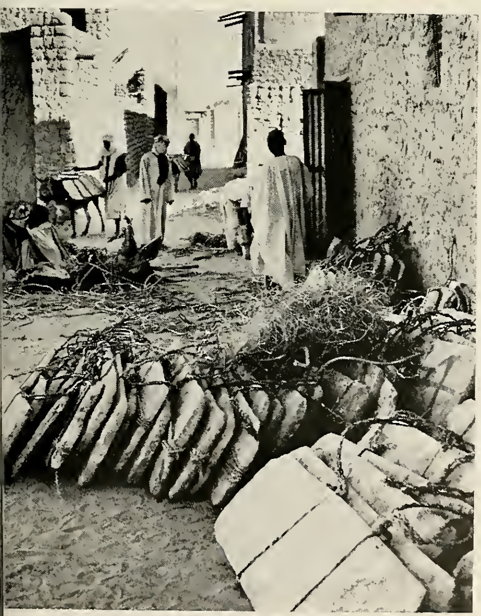
Influencing the city's future was the interaction of three cultural regions: that of the Bambara (one of the several Mandingo tribes) to the west, of the Tuareg to the north, and of the Songhai to the east. This accounts for the city's frequent change of rulers, and for its mixture of religions, races, and customs. The Islamic religion, still dominant in Tombouctou, took hold during the fourteenth century, when the Mandingos, who had been converted earlier, extended their power eastward to the Songhai. After his pilgrimage to Mecca, Mansa Mousa, the emperor of Mali, ordered the construction of the Great Mosque at Tombouctou. Here he installed many of the Muslim scholars who had returned with him. From this beginning, Tombouctou acquired its reputation as a center of Islamic learning. But not until after 1486, when Sonni Ali, leader of the growing Songhai Empire, marched into the city did Tombouctou go on to become one of the most illustrious commercial and cultural cities of the Sudan, and dominant city of the empire.

Its decline began at the end of the sixteenth century when an expedition of Moroccans with an interest in Saharan salt mines defeated the Songhai army and entered Tombouctou. At first the city was a Moroccan colony, with emirs appoint by the sultan; gradually the ties weakened and descenda of Arab troops and local women became the real rulers. T next two centuries saw control of the city shift between t Tuareg and local tribes.

Eventually, the cities of the western Sudan, especia Tombouctou, began to interest European explorers. In t early nineteenth century no fewer than eighteen of th sought first-hand accounts of Tombouctou. Of these o two reached the city and both died before they could retu One was Park, the Scot, who found that the Niger flow east. The other, Major Gordon Laing, had been asked penetrate the interior as far as Tombouctou. In August, 18 he reached the city, but was murdered by his native escor few days out on the return journey.

In 1828, Caillié, the first European to reach Tombouct and return, successfully claimed the 10,000-franc pr

Malian girl, right, felt shy in front of t camera. Below right, the serious business of s dealing goes on at a Tombouctou market; direc below, buyers leave with their slabs of Sahara sa



d by the Paris Geographical Society. When he published count of his journey two years later, he was denounced English as not having made the journey at all and bing it from Laing's notebooks.

ntually, in 1893, a French expedition entered the lary city, followed by colonial administrators. The al period ended with the emergence of the new, inde- nt nation of Mali in 1960.

can still be charmed by a walk along the winding streets of Tombouctou, where some of the buildings are half-buried by the sands. The low rays of the setting sun still turn the gray and ocher of the mud mosques to rich golds and reds, but the great mosques themselves—which formerly housed libraries where Islamic scholars worked—are little more than shells falling into greater disrepair every year.

The real centers of activity now, social as well as commercial, are the marketplaces. Here, merchants and craftsmen (Tombouctou is still noted for its leatherwork, ironwork, and jewelry—although the "gold" of Tombouctou is evident more in sham straw and wax jewelry than in real gold) sit at their stalls. Here too, one sees the social and racial strata of the city: the Arabs, the Songhai, the Tuaregs, and all mixtures in between. Camel caravans still bring salt from mines four hundred miles to the north. The salt is transferred to donkeys for distribution to other points in the Sudan; the camels are loaded with goods to take back north.

Only to the small settlements in the surrounding country—the desert camps of the Arabs, where water is still drawn from hand-dug wells, and the Songhai villages along the river—does Tombouctou still retain some of its glamour and attraction as the "big city."

Downstream from Tombouctou the Niger becomes a single channel. Then, two hundred miles east, after flowing through the narrows of Tosaye (where the eastern Niger captured the western Niger) the river turns southward and reaches Gao.

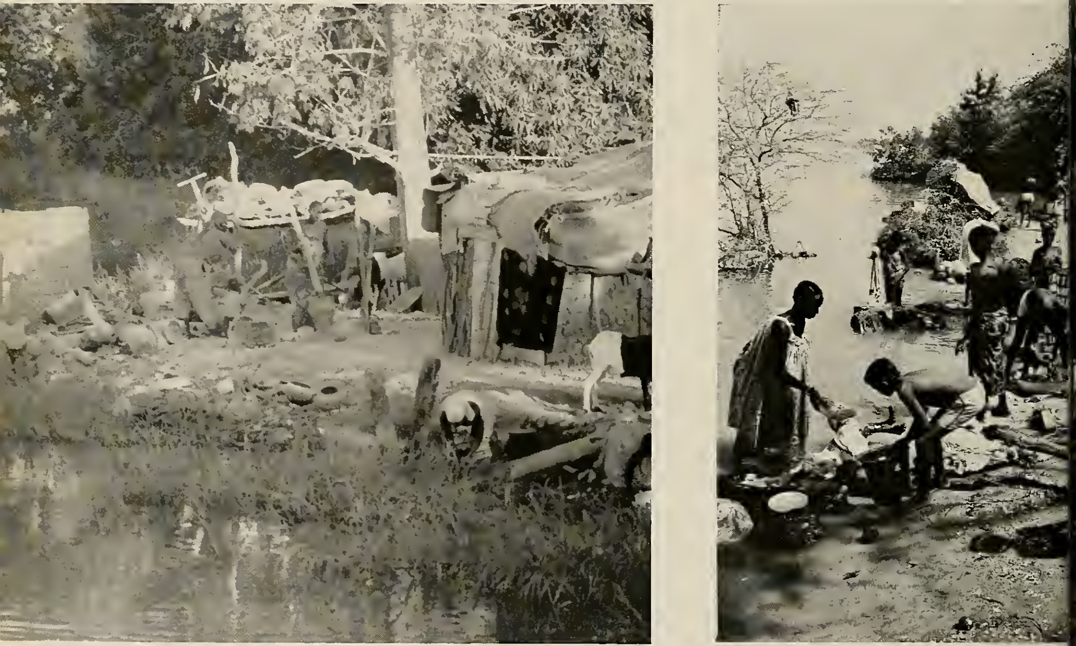
Gao, with characteristics of a frontier outpost, is one of the few cities of the western Sudan that has retained some commercial importance. In ancient times it was the southern terminus of caravan routes coming from as far as Tripoli and Egypt. Until very recently it was also the southern terminus of a trans-Saharan bus service that reached Bechar, in Algeria.

With its bustling market and busy waterfront, Gao presents a very lively picture. Along the tree-lined waterfront one can watch the frequent arrival and departure of boats, and out in the Niger the fishermen can be seen throwing their nets from small dugouts. On the banks women are busy laundering their gaily colored clothes. On festive occasions the local color is enhanced by a friendly invasion of camel-mounted Tuaregs.

The population around Gao is made up mainly of Songhai and Fulani, the latter often in charge of large herds of cattle, sheep, and goats. The situation is changing somewhat, but such herds still constitute the wealth of the owners; few of the animals are sold (enough to pay the government's head tax imposed several years ago) or slaughtered (for an occasional feast). Because of this attitude toward cattle the multimillion dollar slaughterhouse, given to Mali by the Yugoslav government several years ago, has never been in operation. It sits several miles from the town, slowly filling with sand that drifts in from the desert.

Beyond Gao the Niger continues on into the Republic of Niger; 165 miles south of the border it reaches Niamey, the capital. Unlike Mali, Niger retained French advisers after becoming independent in 1960, and in some areas French influence is even expanding. The economic results are obvious, particularly in Niamey, where one finds a few swimming pools, several hotels, paved streets (even a solitary traffic light), and well-stocked stores offering luxury items flown in weekly from Paris. Niamey also trains nurses and civil engineers, has one of the finest museums in West Africa, and even boasts educational television, though on a small scale—so far it serves only nearby bush villages.

Despite its location on the Niger, Niamey's river commerce is limited; navigation upstream into Mali is restricted by the rapids at Ansongo, and downstream by the falls near Bussa and Jebba in Nigeria. The present main link with the rest of West Africa, via the bridge at Gaya, will soon be augmented. A controversial second bridge, at Niamey, will replace the inefficient but picturesque ferry service now operating there and add one more obstacle to travel along the river.



From left: a bridge will soon rise at this q
landing near Niamey; citizens of Gao use the N
waterfront for baths and laundry; some h
arranged for a good view of a visiting dignit

Outside the capital, life in Niger remains much more traditional. About 30 miles downriver and very much like many of Mali's primitive villages lies Say, with a population of about 3,000. We arrived here several days after an unseasonal flood of the Niger had broken through a dike, completely inundating the main part of the village and leaving over half the people homeless. Losses were officially listed as "167 houses, 80 granaries, 50 sacks of millet, 11 bags of rice, 7 sacks of maize, 440 cow, sheep and goat skins, 30 Nigerian beds (highly prized, fancy metal ones), 13 wooden beds, 8 mattresses, 1 carton of sugar, 1 basket of kola, 2 cartons of soap, 30 pieces of silver, and 2 gold earri

It was interesting to note the response of the vill to this damaging aspect of the Niger on their lives. showed complete acceptance. The women continued daily chores, shopping, pounding millet, and washing, the men were busy salvaging what they could of flooded huts. A new village was being constructed on hi ground, and about 100 new straw houses had already completed. The river had risen in their fathers' time villagers told us, but it had gone down; and in their child time it would again rise and go down. In the face of tech advances such traditional outlooks may have bizarre res Farther downstream, where the Kainji Dam is being structed, the natives—unable to abandon the idea tha waters will go down—move their villages only a few fe a time as the dammed waters rise slowly but inexorably

We left the Niger at Say, below which the river, now of the region of the bend, continues another 800 mile its maritime delta in the Gulf of Guinea. But the Middle N is separated from the coast by more than distance; tr tional ways of life are disappearing, and irrigation, po and engineering projects are hastening the advent of twentieth century. But whatever the future holds, the Ni the "great river of West Africa," will continue to pla fundamental role in the lives of the people along its ba

SKY REPORTER

HOT MOON? The old argument whether the moon is a cold chunk of rock or an internally hot body like the earth is still a long way from settlement. With perhaps less than a year to go until men walk on the moon and bring back samples, earthbound scientists are working down to the wire to bolster their opposing cases.

Three scientists at the Air Force Cambridge Research Laboratories took advantage of last April's lunar eclipse to obtain new data for the "hot moon" school. While the moon was dark, they scanned its surface in the infrared wavelengths that are very sensitive to temperature. As expected, they found numerous "hot spots"—patches of material with temperatures slightly higher than those of the surrounding areas. These hot spots cooled quickly during the eclipse.

But along the western edge of the sea called Mare Humorum, extending south from the walled plain Gassendi, they found a straight-line feature, significantly hotter than its surroundings, that did not cool so fast.

The line corresponds with a known crustal fracture more than 100 miles long. Along this fracture are at least four dark-haloed craters, considered a sign of internal explosions. Finally, red flashes that could mark outgassing have been reported at least twelve times in Gassendi in the last two years.

All this evidence, reported by the authors in a paper published in *Science*, points to thermal activity inside the moon. They call the evidence suggestive, rather than conclusive, however, and urge more observations.

GALACTIC FIREWORKS Imagine a galaxy throwing off new galaxies like sparks from a Roman candle. Theoreticians have been doing it for years: now there appears to be observational evidence for this cataclysmic event.

In 1966 Halton Arp published his *Atlas of Peculiar Galaxies*; included were galaxies boasting a jet pushing away from the main body. In 1968 he added the startling postscript that virtually all of the elliptical radio galaxies brighter than 15th magnitude show signs of having ejected strings of second-generation galaxies.

In the *Publications of the Astronomical Society of the Pacific*, Arp lists thirteen of these objects. In each case, secondary galaxies and radio sources tend to form a straight line through the central galaxy.

Arp contends that no mechanism other than ejection could result in the galaxies aligning themselves in straight lines. He goes on, however, to say that the dynamics of such groups makes it most unlikely that they would stay in such straight lines for very long. The secondary galaxies may be up to a hundred times younger than is generally assumed from the type of star found in them. This suggestion, of course, raises a whole new series of problems for the theoreticians.

The mechanism of ejection has topical applications. Quasars are commonly believed to be incredibly en getic objects on the edge of the observable universe. least one group of astronomers, however, believes th were ejected from our own Galaxy in the relativ recent past, and are neither so distant nor so energe as postulated. This group should welcome Arp's findin

In any event, Arp sees the secondary galaxies eject while still in a young, compact form rather than as fu blown assemblages of stars. The stars of the seconda galaxies would then be ejected in turn in a cascade small explosions. Observations lend weight to th scheme. The jets seen emanating from some galaxies a always narrower than the line of secondary galaxi presumed to have been ejected earlier.

PUTTING PULSARS TO WORK New us for pulsars are being suggested even while the deba over what they are, and the search for more, continu around the world (the 11th and 12th were added to th catalogue by Arecibo in Puerto Rico and Jodrell Bar in England). Writing in *Science*, Charles Counselma and Irwin Shapiro of M.I.T. offer these suggestions:

Refining the earth's orbit by measuring arrival tim of the radio pulses.

Computing more accurate ephemeris time (the tim used by astronomers to compensate for irregularities i the earth's motion).

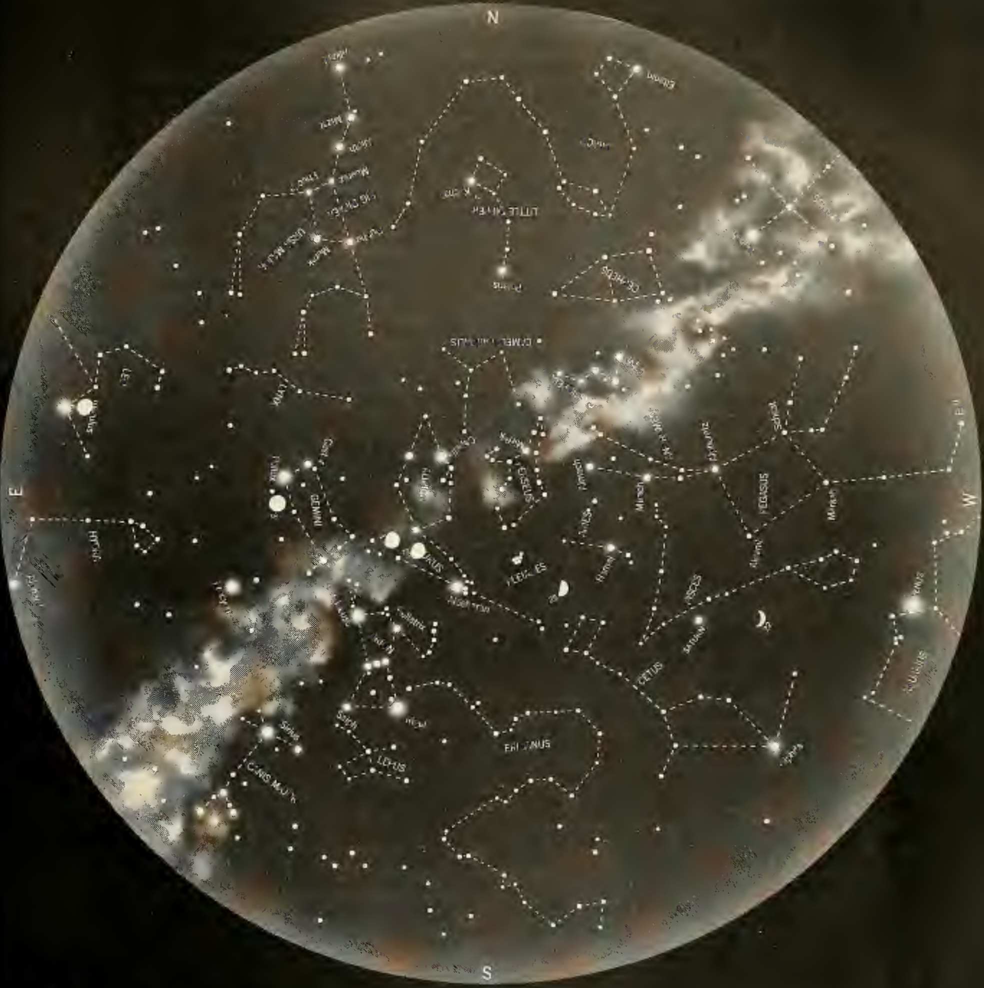
Testing Einstein's theory of general relativity b determining whether pulses are slowed by gravitation a they pass near the sun on their trip to earth.

Using atomic clocks to measure differences in puls arrival time so that astronomers can measure their distance accurately. Then the known laws of radio propagation will enable astronomers to make firm estimates o the number of electrons in the intervening space. Thi knowledge would be useful for our over-all descriptio of the universe.

COSMIC RAYS Physicists in recent years hav studied cosmic rays with heavier and heavier nuclei a higher and higher energies. They are able to say a goo deal about the abundance and make-up of these high speed particles, our only sample of matter originatin outside the solar system.

At a meeting in Cambridge, England, reported in th British journal *Nature*, specialists from the Unite States, Europe, India, and Japan compared new observational data and generally agreed that cosmic rays probably originate in thermonuclear reactions. The questio now is not how the rays originate, but where. The alternatives at this time appear to be either an "ordinary" supernova, a stellar explosion 10 million to 400 millio times brighter than the sun, or an even larger cosmi catastrophe the physicists label simply a "violent event."

John P. Wiley, Jr.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W
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LITTLE DIPPER
Polaris
CEPHEUS
CAMELOPARDALIS
PERSEUS
GEMINI
Pollux
Castor
TAURUS
PLEIADES
ORION
Rigel
Saiph
Sirius
LEPUS
CANIS MAJOR
ERIDANUS
CETUS
PISCES
Hamal
Saturn
PEGASUS
Mirach
Markab
Venus

CELESTIAL EVENTS

The moon is full on January 3, reaches last-quarter on January 11, new moon on January 17, and first-quarter on January 25.

Saturn and Venus are evening stars all month; Mars and Jupiter are morning stars. At dusk, Saturn is high in the southwest and Venus is well above the horizon and very bright in the evening twilight. Mars rises about midnight, Jupiter about an hour before; both planets are high in the south at dawn. Mercury may be seen as an evening star for a few weeks about midmonth.

January 3: Earth is at perihelion, nearest to the sun, at a distance of 91,442,000 miles.

January 4: The nearly full moon will interfere with observations of the Quadrantid meteor shower.

January 10: Look for bright Jupiter near the almost last-quarter moon in the morning sky.

January 11: The bright star Spica is to the left of the moon this morning; Jupiter is to the right.

January 13: Mercury, at greatest elongation east of the sun, appears low in the west after sundown.

January 17: Yesterday's perigee moon and today's new moon produce a perigee spring tide, with a higher than normal range.

January 21: You should easily be able to see Venus below and to the right of the crescent moon in the western sky tonight.

January 23-24: Saturn is to the left of the moon on the evening of the 23rd, to the right on the 24th.

January 26: Venus, at greatest elongation in the evening sky, is at its greatest distance to the left of the setting sun.

THOMAS D. NICHOLSON

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 9:15 P.M. on January 1; 8:20 P.M. on the 15th; 7:15 P.M. on the 31st; but it may be used for about an hour before and after those times.

". . . nothing is great or little otherwise than by comparison," reflected Gulliver after voyaging to Brobdingnag. A look at the significance of size for living organisms, from bacteria to giant sequoias, raises major questions for modern biology.

THE SIZE OF LIFE

by JOHN TYLER BONNER

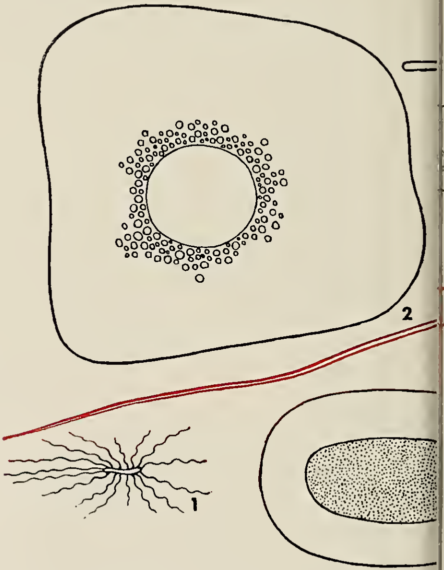
In the full sweep of all the sciences, there are, at one end of the scale, galaxies of inconceivable size, and at the other, objects as minute as atoms and elementary particles. A common characteristic of these extremes is that they are hard to see. Astronomical bodies are too far away and can only be studied with vast telescopes. Atoms and their internal composition are so small that even a microscope is no help. Furthermore, both travel about at speeds beyond our powers of observation, almost beyond our powers of imagination.

Living organisms are in a range somewhere in between. Most plants and animals are of a size we can easily see. It is true that bacteria and other microorganisms may be exceedingly small, but with the help of a microscope, they too can be observed. And the rate of movement for organisms of all sizes—large and small—is such that they can be seen. Even their life histories are within our comprehension. At the size level of living organisms we are closest to our direct experience.

If living organisms are arranged in a scale according to size, the smallest will be bacteria, a few microns in length; the largest will be giant sequoias, some more than 350 feet long, and in the animal kingdom, blue whales, some as much as 100 feet long. When we compare the characteristics of different-sized organisms, a rough direct proportion evolves: the larger the organism, the longer it takes to grow to maturity. It is easiest to consider the period of growth as the time from fertilization—or for asexual organisms, the moment of fission—to the moment the organism is sufficiently mature to be able to reproduce itself. This so-called generation time is a more consistent measure than life-span, or the time that an organism survives before it dies; the latter seems to vary greatly and shows only a crude correlation with size. Generation time, on the other hand, is directly related to size.

Looking at the size extremes again, we find that bacteria divide every half hour or so, while giant sequoias begin producing cones only after 60 years of growth, when they have reached a height of some 260 feet. The reason for this correlation between an organism's size and generation time is obvious. Since each generation is mainly a period of growth, a period of construction, it simply takes longer to build something large than something small, just as it takes longer to build a skyscraper than a one-room shack. There are more operations; more steps that are required.

There is another interesting correlation with size: the larger the organism, the more complex it is. This principle applies to buildings as well as to living constructions, and again the reason is obvious. Increased size brings with it the complicated problems of servicing the organism so that it can operate properly. To give a simple example: if an organism is small, it can get oxygen directly from the environment by diffusion; but if it is large, it is too thick for the oxygen to diffuse inward. Therefore, if combustion is to take place at all in a large animal, there must be lungs or gills for gas exchange and a circulatory system to carry the oxygen inside the body. These structures are highly elaborate: the cost of increased size is considerable in terms of complexity and division of labor.

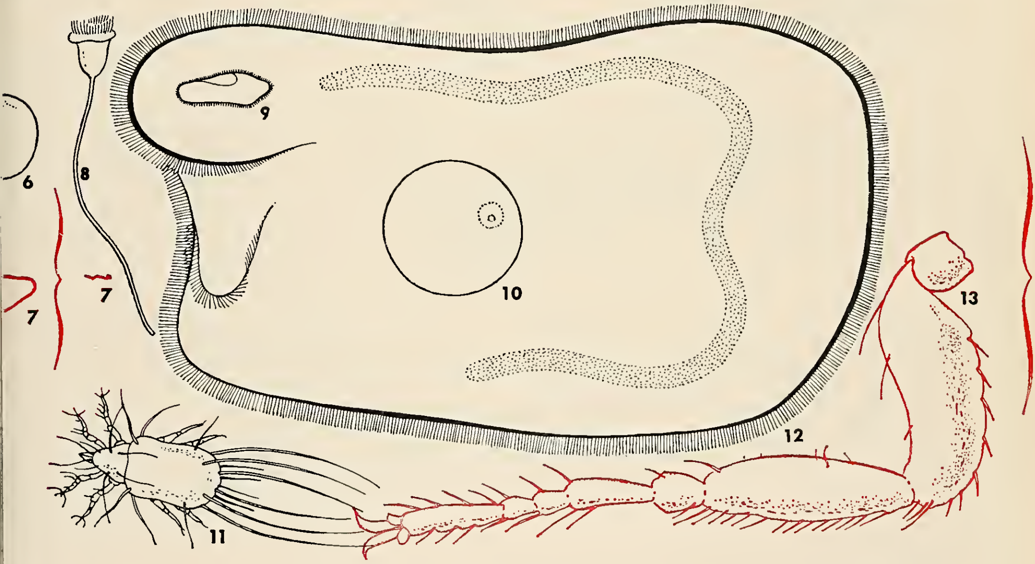


The relative sizes of organisms are shown in the accompanying drawings. In each bracketed group, organisms a
drawn to the same scale; those in color appear again relative in size to the next group in progressio

But why is it necessary to do so much building? We always hear that nature is efficient, even parsimonious, and never does anything in vain. Why, then, do we find any animal or plant larger than a bacterium? As with all such questions the biologist immediately falls back on the notion of natural selection. He argues that there must have been adaptive advantages to being larger and, therefore, selective pressure for size increase. Nothing could be easier to rationalize; for instance, a larger organism can more effectively chase and eat a smaller one. Or in the case of a plant, a larger one can reach above a smaller one and take first chance at the sun's rays for photosynthesis.

There is another aspect to the question of why large organisms require a long period of building. In bacteria and other unicellular organisms, the cell divides in half, nd each half grows until it reaches a mature size ready or the next division. This involves some construction, ut of a relatively simple nature, for only half the organsm is regenerated. But large trees and mammals, or or that matter all reasonably sized animals or plants, o something far more radical than split in half. They art from scratch, from a single cell, and build a large nd complex structure each generation.

Again the harder road seems to have been followed, nd the reason comes from the genetic system. Recombination of genes produces variation required for natral selection and evolutionary change. The genes from e parents are carried in the chromosomes—one set om the father and one from the mother—and these are rought together by fertilization. Each fertilized egg can vary depending upon how its genes are combined, and it is only possible to make this kind of arrangement with single cells. To make the point clear, if an elephant split in two lengthwise, both halves would be the same, and would not offer the variation necessary for natural selection to take place. In bacteria this is not a problem because they are always single cells, and they vary primarily by mutation, by a sudden change in their characteristics. That is, if one cell possesses a gene that has been altered by mutation, it can pass it on directly to its offspring. With large organisms, however, the mechanism of inheritance and variation depends upon their beginning life as single cells. It is not surprising, therefore, that the single-cell stage has been retained, even in the case of the gigantic plants and animals. In fact, it would be fair to say that these larger animals never could have evolved if they had not remained minute single cells at one stage in their life history.

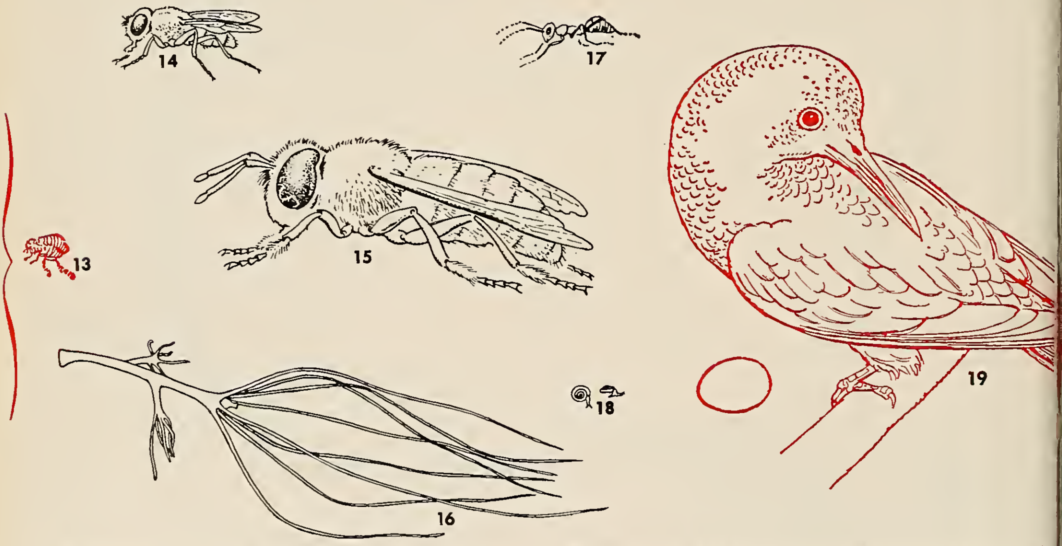


id bacterium **2** human liver cell **3** red blood cell of frog **4** smallest free-living protozoan **5** large bacterium **6** human red blood cell with malaria e **7** human sperm **8** ciliate *Vorticella* **9** ciliate Paramecium **10** human ovum **11** cheese mite **12** largest ciliate protozoan **13** foreleg of common flea.

Now, we come to some of the burning questions of modern biology. How do organisms make these size changes, how does a single cell grow into a whale or a tree? What are the rules that make this construction sufficiently precise so that it is consistent from generation to generation?

It is known that a great many of the messages, the instructions that govern development, come from the genes in the nucleus. In single-celled organisms these instructions are carried out directly in the cytoplasm, the living substance immediately surrounding the nucleus. There is considerable evidence that a set sequence of events, consisting of a series of reactions, alternately affects the nucleus and the cytoplasm. Gene products from the nucleus enter the cytoplasm, which is modified and in turn affects the nucleus, thereby activating a new gene, which makes new products. As one might expect, the biochemist has been busy trying to identify these different substances and to analyze these steps on a biochemical level.

The kind of events that occur in development can be classified in a number of ways, but it is convenient to think of them as three constructive processes: growth, morphogenetic (or form-causing) movement, and differentiation. By growth is meant synthesis of new protoplasm, and in multicellular organisms this is usually accompanied by cell and nuclear division. Morphogenetic movements are found primarily in the embryos of animals where the cells move and produce a new shape. The best-known such movement is that of gastrulation, in which an embryo folds upon itself to become multilayered. In the process of differentiation, different parts of an organism take on a different composition and structure. This is really equivalent to a division of labor, for the parts are associated with different functions. For example, in one body some cells are muscle, some nerve, some cartilage, and these different cell types are organized in well-formed organs and tissues that divide the labor.



13 common flea **14** housefly **15** queen bee **16** common brown hydra **17** medium-sized ant **18** smallest land snail **19** smallest hummingbird with

One of the problems the developmental biologist wishes to solve is the nature of these three processes themselves, even without considering their over-all role in development. In the case of growth this has turned out to be primarily a problem of chemical synthesis, and many of the biochemical pathways are known. The mechanism of morphogenetic movement is far less understood, largely because the mechanism of ameboid motion (which is the way the embryonic cells move) is not known. Many kinds of differentiation are also being studied by the biochemist, who seeks to follow the chemical reactions that lead to the altered structure.

There are other problems, at a higher level, that bring us to the heart of developmental biology. We want to know how these three processes—growth, morphogenetic movement, and differentiation—are controlled so that the end result is the perfect and constant form of the adult. If growth is not held in check, then some parts will grow way out of proportion to others; precisely what appears to occur in the growth of cancers. If morphogenetic movement is not carefully guided, the result is formless chaos. If differentiation is not controlled, the delicate balance of proportions between the different cell and tissue types, as well as their proper positioning in space, is lost. Therefore, we not only want to know how each process occurs but also how it is controlled so that everything comes out to perfection.

We think of each of the processes of development as producing an internal condition that inevitably leads to the next stage. It is like a series of steps in a set sequence; the end result is the inevitable one, given the initial reactants and their initial organization. This is not a new idea; it goes back at least to Aristotle. The problem we face now is to solve the riddle of this sequence of steps.

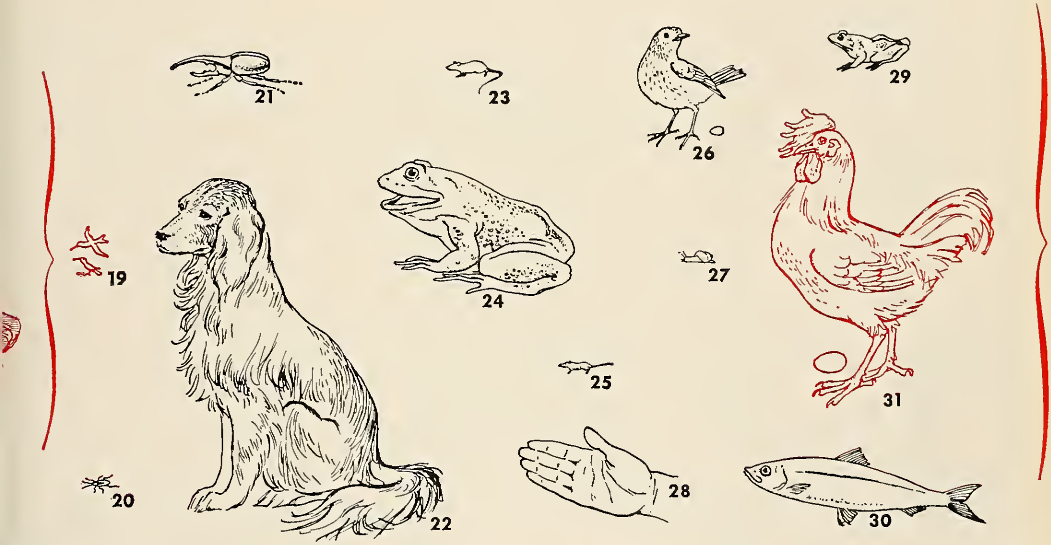
The approach today is to come back to consider the reactants in terms of gene products and changing cytoplasmic environments. We have already mentioned this for unicellular organisms, but the problem becomes more complex in multicellular ones. Here a nucleus divides repeatedly by mitosis, so that each cell apparently contains the complete genetic complement of the organism. How is it possible, in this population of identical nuclei, to obtain differences in parts, that is, differentiation?

If the cells are firmly stuck to one another, as they are in plants with rigid cell walls, then regions of the organism will be different in some way. This may be due to the environment; some parts, for instance, may be more exposed and, therefore, have greater gas exchange than others, or more radiation. This may affect the cytoplasm of those regions, which affects the nuclei, so that nuclei in the various parts receive different signals from the cytoplasm. There are also internal ways in which differences in parts may arise. One of the most interesting, yet puzzling, ways is by the polar movement of substances. Chemicals, such as hormones in the higher plants, are produced by the cells, but move in one direction more than in another. The result is an accumulation of the substance at one end of the organism, again causing a differential stimulus on the nuclei at that end.

If the cells are mobile and can undergo morphogenetic movement, they can enter areas that differ in chemical environment, thereby producing the necessary stimuli to begin the events leading to differentiation. In animals there is usually a combination of growth and morphogenetic movement that, with the help of polar movement of substances and other spacing behavior, produces the desired and consistent adult shape.

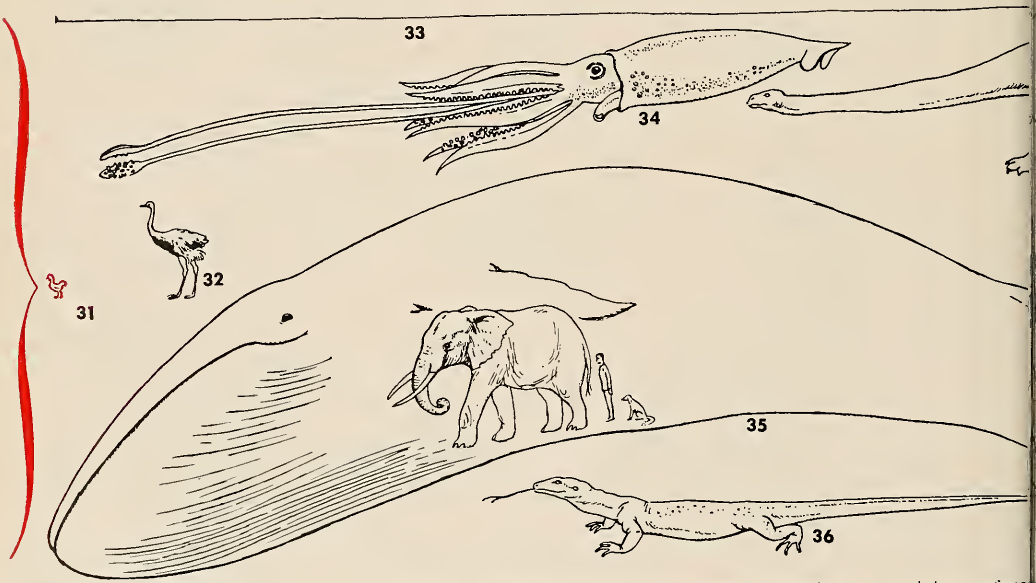
The developmental biologist seeks to understand all these steps so that he can explain the wonderful process of how a fertilized egg turns into a tree or an animal. The difficulty has been that there are so many steps that, if they are considered in terms of chemical reactions, to catalogue them all would be well-nigh impossible. He has, therefore, attempted to find those steps that are particularly significant in the developmental process. Progress has been slow, but hope for the future is great. In the meantime there has been some impatience, for genetics has made such great strides forward, while developmental biology has not yet shown such flowering.

We enter into two of biology's older domains, physiology and anatomy, when we consider the functioning of the adult, the main period of size equilibrium. I will begin with plant anatomy and physiology, because plants are far simpler than animals, but even more important, because most plants do not have a mature stage that corresponds with anything we find among animals. Large trees (as well as many smaller plants) keep growing, they never cease their period of size increase. The botanist refers to this property as continuing embryology. It means that the growth zones at the apex of the plant and at the apexes of all the shoot and root branches continue to grow. So does the cambium, which is responsible for the thickening of the tree's branches and trunk. If the tree seems to have a size limit, it is only that, eventually, through age and decay, the wind will fell it. Other plants, such as annuals, do reach a growth



common cockroach **21** largest beetle **22** dog **23** house mouse **24** largest frog **25** smallest mammal (flying shrew) **26** song thrush with egg **27** common snail **28** human hand **29** common grass frog **30** common herring **31** hen with egg limit, but in this case all the cells, except for those of the seed, die. As a hay field turns brown, or a wheat field turns to light gold, the cells of the plant wither and dry and only a dead stalk is left to hold the seed so it may scatter in the winds.

Yet even though plants do not have an adult stage that corresponds to that of animals, they certainly have an anatomy and a physiology. But plant physiology is largely, for the very reasons we have given, the physiology of development. The concern is with growth hormones, oriented growth movements with respect to light and gravity, and related problems, all of which are completely within the outlook of the developmental biologist. Plants have no nervous system, no muscles, no means of locomotion comparable to that of animals. (For simplicity's sake I am confining my remarks to higher animals and plants, for indeed the distinction between the two is rather fuzzy in more primitive forms.) Among higher plants there are a few exceptions, such as the sensitive plant that lowers its leaf suddenly at a touch, and certain fly-catching plants that move relatively rapidly. But these are physiological curiosities and hardly in the main line of significant problems in biology.



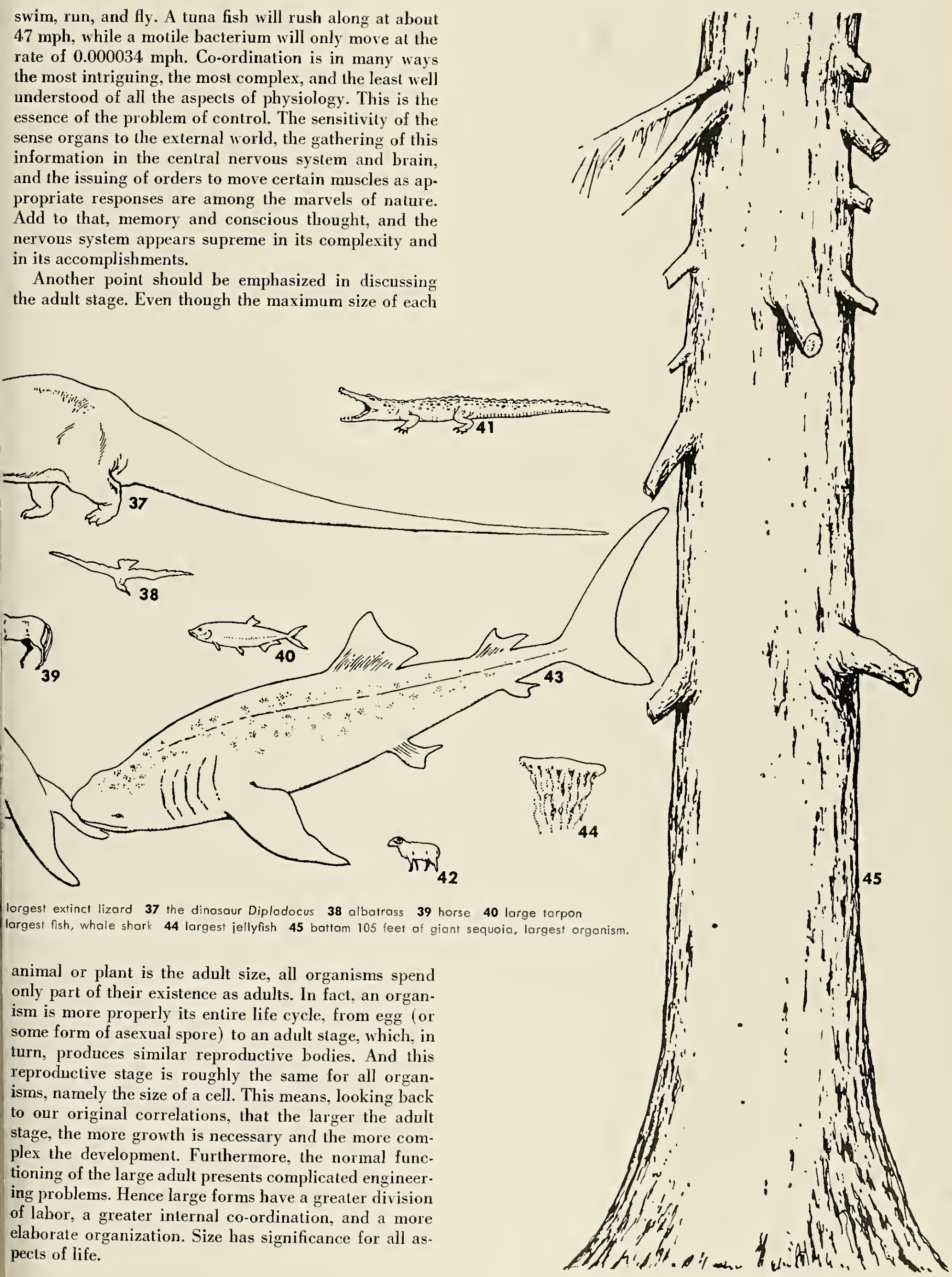
31 hen **32** ostrich **33** largest tapeworm found in man **34** giant squid **35** blue whale, largest animal, with elephant, man, and dog superimpo
41 largest crocodile **42** sh

If we turn to animals, some aspects of adult physiology hold pressing problems for the future, and here again we are confronted with the matter of size level. Physiological activities, for example, can be studied at the size level of the entire organism—the organ, the tissue, the cells; even the biochemical events that take place within the cells.

Let us briefly consider some physiological functions of the whole animal. The assimilation of energy in the form of food is a prime essential. It involves organs to grasp the food, a mouth to begin the food processing, and an alimentary canal to digest the food and absorb it into the blood and thence to the tissues. Another function is locomotion. Swimming, flying, or running involves the contraction of muscle situated in key positions, and all of these processes must be properly co-ordinated, so that the animal can always make the appropriate responses to its changing environment. Of these three primary physiological activities characteristic of living organisms (energy assimilation, locomotion, and co-ordination) the first two are fairly well understood, at least in their broad outline. This is especially true of assimilation. In the case of movement there remain some outstanding questions, especially on the biochemical and cellular level where the answer to the molecular basis of muscle contraction is being sought. There has, however, been much exciting progress along these lines in recent years.

One pertinent point concerning the movement of animals and size should be mentioned. If we group animals according to size categories, and then compare the rates of speed of the fastest animal in each group, we find that the larger the animal, the faster it can move. This relation is rough, but it holds true from the smallest unicellular animal to the large multicellular ones, up to about ten feet in length. Whales and elephants do not have great speed. Furthermore, it holds for animals that swim, run, and fly. A tuna fish will rush along at about 47 mph, while a motile bacterium will only move at the rate of 0.000034 mph. Co-ordination is in many ways the most intriguing, the most complex, and the least well understood of all the aspects of physiology. This is the essence of the problem of control. The sensitivity of the sense organs to the external world, the gathering of this information in the central nervous system and brain, and the issuing of orders to move certain muscles as appropriate responses are among the marvels of nature. Add to that, memory and conscious thought, and the nervous system appears supreme in its complexity and in its accomplishments.

Another point should be emphasized in discussing the adult stage. Even though the maximum size of each



largest extinct lizard **37** the dinosaur *Diplodocus* **38** albatross **39** horse **40** large tarpon largest fish, whale shark **44** largest jellyfish **45** bottom 105 feet of giant sequoia, largest organism.

animal or plant is the adult size, all organisms spend only part of their existence as adults. In fact, an organism is more properly its entire life cycle, from egg (or some form of asexual spore) to an adult stage, which, in turn, produces similar reproductive bodies. And this reproductive stage is roughly the same for all organisms, namely the size of a cell. This means, looking back to our original correlations, that the larger the adult stage, the more growth is necessary and the more complex the development. Furthermore, the normal functioning of the large adult presents complicated engineering problems. Hence large forms have a greater division of labor, a greater internal co-ordination, and a more elaborate organization. Size has significance for all aspects of life.

The Night Insects of West Bengal

by Syd Radinovsky

The evenings in West Bengal were a fine time for us to be afield, accompanied by the sounds of Indian folk music, the calls of night animals, and the distant voices of students reciting their lessons by lamplight. Between the months of May and December, 1967, I had the opportunity to study and photograph the abundant insect life in and around the Indian village of Singur, about 30 miles northeast of Calcutta, in the state of West Bengal.

During daylight hours, relatively few insects appeared. Presumably, the combination of high temperatures (averaging about 100°F.) and lowered humidity relegates the majority of these animals to optimal microenvironments on the cool, moist forest floor or beneath the bark of trees. But when the heat gives way to cooling breezes and the darkness of evening, the eternal signal to arise is reflected by the numbers of insects attracted to our flashlights or to the five outdoor lights that surrounded our field station.

In the 130 nights that I devoted to the study of insects, lepidopterans (moths), dipterans (two-winged flies), hemipterans (true bugs), and coleopterans (beetles) made up the bulk of the creatures observed, although representatives of most other insect orders, numbering several thousand species were seen in total. Since some of these insects may not have been previously reported or assigned scientific names, some of the photos on the opposite page are identified only in a tentative way.

Some of the insects that collected at our lights were noticeably colored in a protective manner, resembling leaves or lichen-covered bark. Many of West Bengal's species, however, are richly marked with brilliant and iridescent hues. One may ponder the survival value of such coloration, but experimental evidence indicates that the defensive value of exquisite colors and patterns is no more accidental than the stings, poison glands, and powerful pincers of predators. These characteristics derived from the evolutionary processes of variation, mutation, and natural selection. The natural selectors in such cases were the predators, which selected or destroyed those insects that were most palatable or appeared to be so. Those least palatable, and with a color pattern or form to advertise it, survived. For every successful model today, a thousand may have gone by the wayside.

Some ecologists have aptly stated that night is the winter of the tropics. The greater humidity at night makes it possible for many stenohygric insects (those that can tolerate only small deviations in moisture) to exist where the daytime conditions are intolerable. Similarly, the activity of certain stenothermal insects may be restricted to the hours of darkness. Yet, on adjacent evenings with seemingly identical conditions of temperature and humidity, insect activity varied considerably. Perhaps other climatological factors such as barometric pressure, wind velocity and direction, and cloud cover have a considerable effect on the behavior of the various species.

This question of insect activity is only imperfectly understood at present and the extension of our knowledge will depend on the study of variations within the myriad microclimates of tropical habitats. In general, little is known of the behavior of tropical insects within their natural environments, with the exception of those that destroy crops, carry disease, or in some other way directly influence the affairs of man. Due to the great difficulties involved in conducting behavioral research in natural, tropical microhabitats, the accumulation of this information will be a slow process.

But time is of little importance in West Bengal's tropical forests, where the thousands of nocturnal species live their lives attuned to the dark and ageless rhythms of the night.

Hawk moth

Rhinoceros beetle

Cerambycid beetle

Nocturnal moth

Buprestid beetle

Long-horned wood-boring beetles

Iceland's Thermal

An Icelandic saga tells of a tenth-century hero who stood on a coastal peak to guard an ancient settlement from raids by watching for the sails of Viking marauders. Today, this same peak is located near Hveragerdi, almost twenty miles inland; its location changed by intense deformational forces that raised the land and caused the shoreline to shift to the south. But this is not an unusual occurrence on this North Atlantic island, for Iceland is the scene of more active geologic forces than any comparably sized segment of the earth's surface.

Iceland, although smaller than New York State, is the largest land portion of the mid-Atlantic Ridge, a huge, largely submarine mountain chain, which stretches in a sinuou pattern for about 12,000 miles alon the ocean's center from the Arctic t the Antarctic. Some of the mountai of this chain extend for as much three miles above the ocean floo Other exposed segments of the ridg include the Azores, St. Paul Rock Ascension Island, St. Helena, an Tristan da Cunha. Some geologis

Geology

By Julian Kane

Photographs by William A. Keith

ink that the basaltic floor of the tlantic continues to split as new lcanic material is forced up rough faults along the ridge, and at the sea floor is widening, forc-g the continents on either side of e ocean to move farther apart. The ntinuing geologic activity along e ridge may well be part of a huge nvection cycle, involving both the earth's crust and the hot mantle rock that extends for hundreds of miles into the earth. Large tension cracks (*gjas*), rift valleys (grabens), extensive earthquakes, and volcanic eruptions along the rift zone that bisects Iceland are surficial manifestations of the changes occurring far underground.

The bedrock of Iceland is mostly basaltic lava and ejected volcanic debris, the bulk of which was formed in early Cenozoic times (40-60 million years ago). Most of the recent igneous activity, however, has been confined to an irregularly linear area—approximately 50 by 250 miles in size—that runs roughly in a northeast direction through the central part of the island. Because of the igneous activity, fossils are rare and time dating is mostly limited to radioactive determinations.

In addition to containing a great number and variety of volcanic cones, Iceland is unique in having the only active fissure flows that form lava plains and lava plateaus. These are made up of successive outpourings of extremely fluid lavas, capable of covering many square miles prior to congealing in essentially horizontal layers. When magma pressures build up from below, the molten material readily finds its way up to the surface through the linear joints and cracks near the island's center, and fissure flows result. Careful measurements along the Almannagja, a major, five-mile fissure located thirty miles from Reykjavik, have shown it to be slowly widening over a period of years—a result of tensional forces related to the spreading of the sea floor. The steep eroded edges of hardened lava flows frequently exhibit faceted rock columns (columnar joints), formed when shrinkage cracks developed in the cooling lava.

The Reykjanes Peninsula, on which the capital city of Reykjavik is located, has experienced many recent earthquakes. Their persistence, coupled with the birth of new

Islands south of Iceland lie along the Atlantic zone of volcanic activity. Eruptions between 1963 and 1966 formed those at left; one has since completely eroded. Older island, below, now contains a fishing village of 5,000 inhabitants.

Volcanic cobbles in a glacial stream, above, are gradually eroded into round, smooth shapes. Polygonal columns of basaltic rock, below left, form as lava cools and shrinks. Clouds of water vapor from a hot spring, below right, rise into the cold Icelandic air. Hot springs result from the heating of ground water by the volcanic rock beneath.

gjas and hot springs in the area, indicates that additional volcanic eruptions may be expected in the near future, and investigations are under way to predict imminent volcanic activity in order to avoid unnecessary loss of life and property. Infrared detectors capable of locating areas of significant ground heat increases are used on the surface, from airplanes, and from space satellites. Five regions have been identified in which temperature increases indicate potential eruption sites: Katla, Hekla, Odadahraun, Askja, and Surtsey. The last area, a new volcano, has been erupting sporadically since 1963 when it first appeared as an island in the cold Atlantic waters off the south coast of Iceland (NATURAL HISTORY, March, 1967). Mount Hekla, Iceland's most celebrated volcano, has experienced major eruptions of ejecta and lava approximately twice per century since A.D. 1100. From treeless lava plains 65 miles east of Reykjavik, this elongated composite cone, 4,900 feet high, stands starkly up against the gray, leaden skies.

Hekla's 1947 eruption began as a tremendous ejecta discharge that reached to the stratosphere, darkening the entire countryside and sending ash fragments as far as Scandi-

ivia, 1,000 miles east of Iceland. he lavas, which for more than a ear poured out intermittently from any of the vents along the summit, d temperatures of approximately 900°F., and added 450 feet to the eight of the cone. After the erup- ons ceased in the spring of 1948. ense volcanic gases continued to eep down the flanks of the volcano, llecting in nearby depressions here grazing animals were occa- onally suffocated by the fumes.

Periodically, portions of Iceland are devastated by great turbu- nt floods known as *jokulhlaups*. hese are sudden outpourings of bil- ons of cubic feet of melted glacial ater and result from the subglacial ruptions of periodically active vol- anoes, which melt out large pockets f water inside an icesheet. Huge olumes of ice are melted and re- ined under the glacier until a eakness is found along one side of e glacial terminus. The pent-up aters then burst through the rupture nd surge across the countryside car- ying huge ice fragments and bould- rs at velocities of about 60 miles per our. Farmhouses, barns, people, nd livestock in the flood's path are ll swept up in a maelstrom from which virtually nothing escapes.

Two active subglacial volcanoes, Katla and Grimsvotn, whose flanks nd tops are almost completely cov- red by broad continental ice sheets, ave produced most of the country's ecent large *jokulhlaups*. Katla, lying beneath the Myrdalsjokull glacier in outhern Iceland, erupts about twice er century, unleashing a *jokulhlaup* hat rushes pell-mell across the vast Myrdalsandur plains toward the outh coast. Although its maximum urge lasted only two days, the 1918 Katla *jokulhlaup* exceeded the dis- harge rate of the world's largest iver, the Amazon. Katla's most re- cent *jokulhlaup*, in 1955, was rela- ively small, but infrared measurements from the Nimbus weather satel- ite indicate that the volcano may be preparing to unleash its fury and de- struction once again.

Iceland's coastal areas south of he Myrdalsjokull and Vatnajokull ce sheets contain wide, flat *sandurs* —broad plains made up of poorly sorted, irregularly layered sand, gravel, and erratic boulder deposits left by glacial meltwaters and successive *jokulhlaups*. Many glacier-fed streams meander southward across these plains toward the sea, while erosion and deposition along their banks cause the streams to shift their beds constantly, to the discomfort of cartographers and local farmers.

Many *sandur* streams in Iceland are unusual because of the rapid erosion of the inner banks along their curves. Normally, streams tend to accumulate deposits on their inner banks and to erode their outer ones since water usually slows down when going around the inner bank of a curve. In Iceland, however, oblique sand or gravel bars left by overloaded glacial meltwaters are often present in the curves at such an angle that the force of the flow may be deflected inward, causing erosion.

One of the world's three major geyser areas is located about 35 miles northwest of Mount Hekla (Yellowstone Park and the Taupo-Rotorua district in New Zealand are the other two). Grand Geysir, has largely ceased its activity during this century after having spouted frequently for hundreds of years. Its huge geyser cone of siliceous deposits—from the hot waters that evaporated after each eruption—is surrounded by about two dozen geysers of various sizes and periods of eruption.

The rarity of geysers throughout the world is determined by the unusual combination of factors essential to their existence. An extensive joint system must reach down into subsurface bedrock heated by adjacent magma. A high water-table (within a few yards of the surface) is also necessary. As ground water seeps into the joint system. the bottom waters are heated far above the normal surface boiling point due to the pressure of the overlying water. The heat spreads through the entire column of water, whose volume expands until its upper level reaches the surface of the ground. Some of the water then overflows out of the ground, sharply reducing pressure on the superheated waters at the bottom of the fissure. These are immediately transformed to gaseous vapors whose volume increases some 1,700-fold, forcing vapor, water, and steam to erupt from the vent until the pressure is spent. Then the system slowly refills with ground water as the cycle begins anew.

About 700 natural hot springs are scattered across Iceland. The hottest (more than 160° F.) are located in the central rift area of volcanism and geologic activity. In some cases, boiling temperatures cause hissing vapors to escape from vents under pressure and to condense as turbulent, misty jets. Whenever soil or clay covers these vents, noisy, bubbling mud pools are formed.

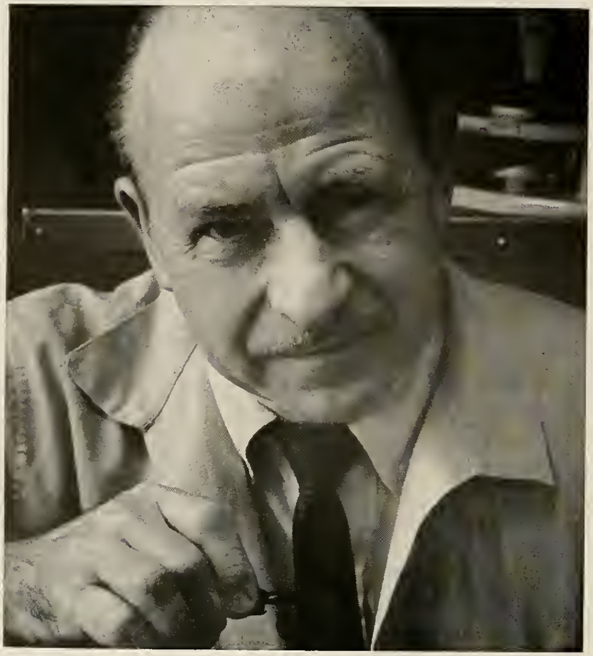
Many of the houses on the island are heated by these geothermal waters. Almost every building in Reykjavik, for instance, is heated by water tapped from 1,000- to 2,000-foot boreholes drilled into the earth. The water, with a temperature of about 220° F. at its underground source about ten miles from town, enters the homes at about 212° F., losing little heat in transit.

Hydrothermal energy is of vital importance to Iceland's economy, inasmuch as few trees grow on the island at present, and no significant coal or petroleum is found in the volcanic bedrock. Birch forests, which blanketed parts of the country centuries ago, never recovered from extensive cuttings by early settlers.

Hveragerdi is a small town located approximately 25 miles from Reykjavik. This little village, less than 200 miles from the Arctic Circle, is well known for its fruits, vegetables and flowers—even tropical varieties—the result of its hydrothermally heated hothouses. Many of the homes and work buildings are built right over the hot springs. Several years ago one family got more hydrothermal heat than it wanted when a crack opened in the kitchen floor and scalding water gushed through the house. Icelanders, however, are glad to deal with relatively small inconveniences in return for their inexpensive, pollution-free, and readily available heat source. With the benefit of centuries of experience, they have learned to cope with, use, and appreciate their country's unique, if sometimes troublesome, geologic resources.

T. C. Schneirla and Animal Behavior

by Ethel Tobach



Dr. Theodore C. Schneirla, late curator of The American Museum's Department of Animal Behavior.

It is hard to accept the fact that a dialogue is irrevocably terminated by death. The discussion may continue, but the deceased speaks only from the past, and the living answer only from hindsight. Theodore C. Schneirla, late curator of The American Museum's Department of Animal Behavior, now participates in the discussion of problems in behavioral science only through his writings and experimental works. His active career as a comparative psychologist and biologist ended with his death in August, 1968, and his thinking is now mediated through those who knew him personally and through those who read his books and papers.

The American Museum of Natural History and its visitors have an additional legacy in the form of the Invertebrate Behavior Alcove on the first floor of our building. While this exhibit reflects the ingenuity and hard work of many specialists on the Museum staff, and of scientists outside the Museum, it is a multidimensional realization of Schneirla's approach to the study of behavior.

Fundamental to his theory of the evolution and development of animal behavior is the concept of levels of organization and integration. While this concept is widely known within the scientific community, Schneirla was the leading proponent of this approach in its application to animal behavior.

The concept proposes a hierarchical ordering of nature in terms of structure and function. Invertebrates, for instance, can be arranged in a series of increasingly complex levels,

rom the lowly acellular *Para-*
ecium to the highly developed
ocial insect. As structure and
unction become more differen-
ated and elaborate, the inte-
ration of systems within the
rganism becomes more com-
lex and the animal's response
stimuli becomes more varied.
he evolution of endocrine and
ervous systems, for example,
akes possible an increasing
ariety of relationships between
e animal and its environment,
s well as between the systems
emselves.

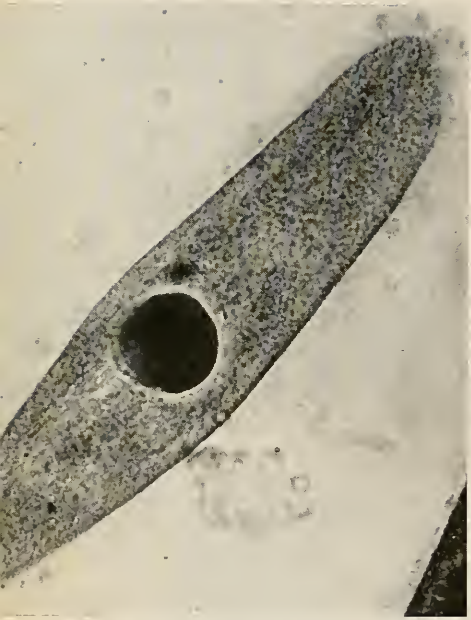
As Schneirla planned the Mu-
eum's exhibit, the first beha-
ioral pattern brought to the
iewer's attention is that of
rhythmic activity," a rather
low level" type of behavior. In
is context, "low" does not
ean inferior, but rather "ele-
entary," for rhythmicity is a
asic pattern found in all
ecies, in one form or another.
mong the species, however,
e complexity of rhythmic
ehavior varies considerably.
chneirla demonstrated this by
ree levels of rhythmic beha-
ior within his exhibit: the
ovement of plankton, the
pening and closing of the
ussel shell, and the integra-
on of rhythmicity and memory
bees.

The daily vertical movement
f plankton (a collection of
inute sea plants and animals)
primarily a response to the
yclic changes in light intensity.
he rhythmic opening and
losing of a bivalve, which per-
ists in the absence of immedi-
te stimulation, is a more com-
lex level of behavior involving
he feeding process. An even
igher form of rhythmic behavior involves the feeding and foraging behavior of honeybees whereby the insects visit different food sources according to the hour at which certain flowers open and close. In all three instances, the rhythmicity is evident. But in each instance, with different levels of structural organization, the integration of the various physiological systems (neural and alimentary) varies in complexity, as does the character of the animal's response to its environment.

Portions of the behavioral alcove represent an up-to-date panoramic expression of the classic textbook Dr. Schneirla wrote with Norman R. F. Maier in 1935, *Principles of Animal Psychology* (reprinted in 1964), which stressed that the comparative method must give equal weight both to behavioral differences and similarities, in order to properly understand the relationship of living creatures to their surroundings. Locomotion, feeding, reproduction, and reaction to various stimuli are characteristics of all animals, but vary in their manifestation from species to species. Schneirla continually stressed that study of a given behavioral pattern called for knowledge of an animal's specific physiological characteristics and its environmental setting.

He also enjoyed and devoted a great deal of time to the study of animal behavior in its typical setting as well as in the laboratory. Since he loved observing the natural behavior of animals, he was particularly sensitive to the many distortions of this behavior to suit human ends. In the invertebrate behavioral ex-

Interaction and exchange of stimulation among members of a community are common to all social organization, but differ considerably among species. Black carpenter ants, above, display both a high degree of social interaction and a complex form of food-sharing behavior. In bulldog ants, below, these social activities remain relatively simple.



All animals respond to stimuli, but the nature of the response is determined by a species' evolutionary history and by the individual's experience. The acellular paramecium, above, the sea anemone and the insects in a "flea circus," opposite page, display three levels of organization insofar as their capacities for movement and for making use of past experience are concerned. These differing abilities modify the response of each species to a given stimulus. In the case of a flea circus, the insect's stereotyped response to the stimuli of light and pressure is used by the "trainer" to create the illusion that the animal can obey orders and perform complex tasks.

hibit, for instance, he provides an amusing, but scientifically valid, explanation of the behavioral mechanisms underlying the "flea circus." He shows that by manipulating the flea's stereotyped behavior, the "trainer" creates the illusion that the animal is capable of obeying orders and performing complex tasks.

Schneirla was well aware that illusions are fostered not only in the world of entertainment but in the laboratory as well. He applied the most rigorous criteria for testing to his own experimental assumptions and hypotheses. He also recognized the limitations of even the most careful field observations and urged that they be confirmed in the laboratory.

One of Schneirla's contributions to the study of behavior was his theory of the socialization process as it evolved throughout the animal world. His theory states that social bond formation results from the process of mutual exchange of stimuli by two or more individuals. It is a significant modification of the earlier concept of trophallaxis formulated by biologist W. M. Wheeler. Wheeler proposed that the exchange of nutriment was a potent force in the formulation of social bonds. Schneirla's work with army ants led him to discover that other types of stimulation and exchange were equally important, depending on the stage of development of the interacting individuals and the level of organization attained by the species.

When Schneirla began his investigations of army ants in 1932, he was concerned with finding an explanation for the cycles of emigratory and stationary behavior of the colony, a highly cohesive social group. These regular changes in colony activity could not be explained in terms of climatic factors, scarcity or abundance of food, or any other objective condition in the animal's habitat. To find an answer to this question, he spent a good deal of time in the field, following columns of moving ants wherever they might lead him.

Schneirla's mastery of the inductive process enabled him to analyze the behavior of the army ant and to offer an explanatory hypothesis about the underlying processes responsible for its behavior. Schneirla could not accept the facile explanation of an untestable concept such as instinct. He viewed such terms as "instinct" and "drive" as semantic umbrellas, which served to conceal science's inability to determine the real causes of various types of animal behavior Rather than be satisfied with the "instinctive" explanation o the emigration patterns, he carefully studied the changing developmental stages of the ants and noted that the proportion o workers, larvae, pupae, and callows within an ant colony is constantly changing. In the emigratory period, there are many more active, feeding larvae; in the relatively quiescent period there are many pupae. The tactile stimulation of worker ants by the active larvae was differen from that afforded by sluggish callows. Similarly, the queen ant's role depends on her physio logical state. When she is heavy with unlaid eggs, the queen stimulates the workers differ ly than after the eggs have n laid. These changes in de- e of stimulation excite the rkers to different levels of ivity, resulting in a cyclic pat- n of emigration.

From these observations, neirla developed hypotheses ating to the formation of so- l bonds among the various ments of the ant population l to the role of reciprocal nulation. From this start, he gan to formulate his theory of ialization for all animal cies.

The process of reciprocal nulation is basic to all social ganization. At each phyletic el, however, the process oper- s within the context of the uctural and functional char- eristics of that level, as illus- ted in Schneirla's behavioral ibit by the comparison of the d-sharing patterns of black penter ants and bulldog ants. is pattern is relatively simple the bulldog ants, where the rkers are similar in size and ucture. Interaction within the ony is based on simple tactile d chemical stimuli. Carpenter ts, however, are highly diver- ed in form and function; ir food-sharing behavior is ch more organized, with a h degree of responsive inter- ion among larvae, workers, d queen.

Both these species of ants, like other animals that are not able of storing and integrat- previous experience except a limited way, exhibit what hneirla termed a "bio-social" m of social organization. In higher vertebrates, many spe- s form social bonds in which attraction of the stimuli presented by one individual to another is based on an integration of past experience, as in certain monogamous birds, or the complex social organization of a group of gorillas. Such group organization he defined as "psychosocial."

Two corollaries follow from the concept of levels of organization. The first is that each level requires its own techniques for study. The second is that understanding the mechanisms of one level does not enable one to predict phenomena on the higher levels.

Schneirla stressed that two errors in logic were frequently made by those who did not recognize the implications of those corollaries, particularly when trying to relate man's behavior to that of other animals. One error involves anthropomorphism—imputing human-like abilities to animals. Schneirla was intensively engaged in this argument early in his career. In a critique of a paper that had described the "cruelty" of lower animals' behavior, he pointed out that without the potential for symbolization, language, and culture, the behavior of an animal could not be construed as "cruel" from any but a human point of view.

In the last few years, he had been dealing with the other type of error, zoomorphism—the reduction of man's behavior to that of lower animals—as expressed in recent books on territoriality and aggression by Lorenz and Ardrey. Schneirla felt that this approach was not only scientifically indefensible but also had profoundly dangerous consequences for man's survival be-

The opening and closing of a bivalve parallels the rising and falling of tides. This is an example of biological rhythm, which is characteristic of all species.

cause it led to false conclusions about human behavior (NATURAL HISTORY, December, 1966).

In his writings, Schneirla stressed the need to understand human behavior through the principles and techniques suitable to the high level of human social organization. For Schneirla, to do otherwise was to oversimplify and vulgarize the comparative method. More significantly, it meant overlooking the special plasticity of man's nervous system with its great potential for modifying behavior. The crass extrapolation to man of processes relevant to infrahuman levels denies his capabilities of egalitarian control of his environment and behavior, and the solution of his problems within humane values.

The dichotomous classification of behavior into instinct and learning is omitted from the behavioral alcove, as it was from his thinking. In the history of man's pursuit of knowledge about the life around him, the concept of instinct was an easy and temporizing explanation for our observations. We are struck by the seeming invariance and rigidity of those stereotyped behavioral patterns that a species displays without any known previous experiences or apparent preparation. Yet, Schneirla elegantly demonstrates the possibility of understanding the evolution of behavior without imposing the experimentally undefinable concept of instinct. Rather, he noted that stereotyped behavior depends upon characteristics that develop in an animal living within an environment typical of its species.

Schneirla saw development as
a fusion of other processes
experience, growth, and matur
tion. He gave new breadth to th
term "experience," which her
tofore had generally been i
terpreted only as the stimul
tion that an animal receive
from external sources. Fo
Schneirla, however, the exper
ence of an animal included a
types of stimulation. at all stag
of development. Thus, the "sti
ulation" afforded to the orga
ism by the chromosomal mat
rial was included within h
definition of this concept.

At all times. an organism
structure and function are t
derivative of the early biochem
cal potential present in the g
netic material. This potentia
however. can only be realize
under certain conditions. In t
evolutionary process, these co
ditions and potentials ha
emerged compatibly to bri
about the existence of the sp
cies. All levels of organizati
(biochemical, behavioral, soci
and ecological) contribute
this compatibility.

Schneirla's theory of develo
ment is thus based on the co
cept of levels of organization,
the explanation of behavior
phenomena in terms of obser
able processes (rather th
upon innate drives), and on t
constancy of change. These la
two ideas were significant incl
sions in his original formulati
of a "biphasic approach/wit
drawal" process as a basis f
behavior. Starting with the o
servations of Jennings
founder of the science of anim
behavior), Schneirla noted th
animals tend to approach
source of mild stimulation a
to withdraw from a source of i

se stimulation, whatever the
ure of that stimulation might
Schneirla emphasized, how-
r, that the stimuli were acting
an organism in a particular
te, derived not only from the
mal's long-term history but
o from the immediate history
the organism. An animal that
been exposed to a bright
nt for a relatively long period
ime would react differently to
ewly presented light than an
mal that has been in the dark
or to presentation. The bi-
isic response is also depend-
on the stage of development
the organism and upon its
letic level.

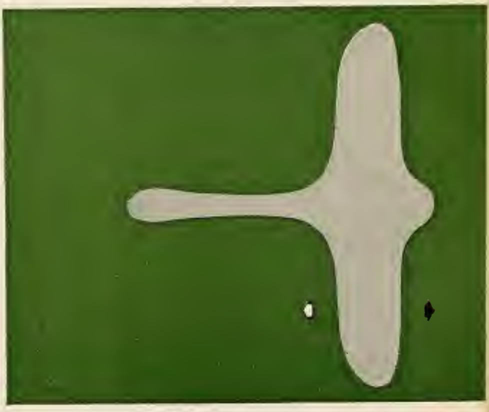
his biphasic approach/with-
wal concept has been of value
studying several behavioral
nomena. Among these is the
blem of motivation. One need
propose some preformed
ve to "motivate," that is, to
ng about a change in the
mal's activity. Rather, the
ponses of the animal are
ctively brought about as a
ction of the intensity of in-
nal and external stimuli and
a function of the history and
sent state of the organism.

his concept is also proving
ful in the investigation of
nprinting," or, as Schneirla
med it, the "early approach-
ation and following re-
nse." This complex pattern
ms to play an important role
the socialization of birds. The
ensity of stimulation, state of
organism, type of experi-
ce, and stage of development
all found to be relevant to
s behavior pattern.

It is also possible to under-
nd the responses of animals to
edators in terms of the intensity of stimulation presented, as in Tinbergen's experiment with the hawk-goose model. Schneirla proposed that the shape of the hawk looming overhead presents an intense stimulus to the prey animal (chicks and ducklings were used in these experiments), and therefore, results in withdrawal behavior. The long, thin neck of the gooselike shape, however, presents a stimulus of lesser intensity and does not bring about withdrawal (*see diagram*). Some ethologists attribute the prey's response to an innate mechanism.

In Schneirla's long history of involvement with the problem of instinct, his approach to ethological principles was always scholarly and serious. He appreciated the ethological stress on the evolution of behavior in the context of the species-typical environment, but criticized the attempt to explain the evolutionary process in terms of a dichotomy between nature and nurture. Instead, he called for an explanation of behavioral phenomena based on all levels of organization—the ontogenetic as well as the phyletic.

He saw the limitations in plasticity and adaptiveness that lead to stereotypy in lower animals, and called on man to develop his own truly human freedom from stereotypy. Schneirla regarded human nature not as a negative factor, to be held at bay and under control, but as a potential for developing the most beneficent relationships among men, and between man and his environment. In Schneirla's work and social outlook, he exemplified this healthy optimism about the future of humanity.



Chicks and ducklings are not frightened by the motion of the "hawk-goose" silhouette, above, from right to left. Opposite movement causes them to withdraw. Schneirla suggested that withdrawal resulted from the intensity (size and motion) of the predator's shape, rather than from an "instinctive" reaction to the predator.

The socialization of animals is a function of their developmental history. Cats and white rats reared together in a laboratory situation do not display the predator–prey interaction typical of the two species in a natural setting.

The Zoologist's Library

by Lorus and Margery Milne

As we glance about at the hundreds of books that fill the shelves in our study and overflow into other parts of the house, we see quite a few that are worn from frequent use. Some stir a warm nostalgic feeling, even if we read them less often. Still others are there for reference, giving technical details when we need these from a reliable source.

The book we would surely miss most, if deprived of it, is our *Webster's New International Dictionary*, second edition, unabridged (1958). Not even the twenty-four volumes of the *Encyclopaedia Britannica* have as much of the information we seek, given so succinctly, although we use them far more often than we anticipated before we owned the set.

To satisfy our curiosity and round out our understanding of animals and of the plants that nourish and shelter them, directly or indirectly, whether in our own part of the world or farther off, we need many books. We refresh our memories or extend our knowledge from volumes containing descriptions, illustrations, measurements, and information on habits. When the question relates to some animal or plant neighbor, or one special enough to be displayed in a zoo, a garden, or to have a place in literature, we go to the *Field Book of Natural History* (1949), by E. Laurence Palmer, who tells us he is revising it, although information of this type scarcely goes out of date.

The names of animals, both scientific and common, and the places where they are found do change without notice. This makes us highly conscious of the publication date for each book. We definitely prefer a newer volume if it is full of information. To communicate in modern times, we need contemporary books. It is particularly convenient when the same useful book is repeatedly updated, without changing its fundamental form. One of our favorites, *General Zoology*, by T. I. Storer and R. L. Usinger, has undergone this kind of transformation—from the 1943 version to the present fourth edition (1965).

For identification of mammals and birds, reptiles and amphibians, butterflies and animal tracks, we reach for the appropriate volume from the fine series of "Field Guides" begun and edited by Roger Tory Peterson. We still go to our worn copy of *Field Book of Insects* (2nd edition, 1921), by Frank E. Lutz, which we prefer to the later edition because the color plates are spread throughout, not clumped irrelevantly, and the appendixes include information on caterpillars, insect galls, and other lore missing elsewhere in our library. No more recent book has replaced the *Field Book of Marine Fishes*, by C. M. Breder, Jr. (1929), in the same series, although it too needs updating.

Of course, no book can ever be complete if it covers more than a small area. *The Complete Field Guide to American Wildlife* (1959), by H. H. Collins, is no exception, even when qualified by the subtitle *East, Central and North.* It does contain a wealth of interesting information on mammals, birds, reptiles, amphibians, fishes, and some marine invertebrates (including seashells). But it excludes all insects, spiders, centipedes, millipedes, and land and freshwater crustaceans, which are just as much American wildlife as any fish.

The Burmeister's frog peering u
great, catlike eyes and the gr
of Atlantic spadefish are fr
the "World of Nature" ser

For quick reference on birds, we go to *Birds of North America: A Guide to Field Identification* (1966), by Chandler Robbins, Bertel Bruun, and Herbert S. Zim, which is a full-color account in one handy volume. For more details, we have to rely on bigger books or more local ones, such as Victor H. Cahalane's *Mammals of North America* (1947), *The Mammals of North America* (1959), by E. R. Hall and K. R. Kelson, or even reprints such as *The Fishes of the Gulf of Maine* (1950), by H. B. Bigelow and W. C. Schroeder, now available again from the Museum of Comparative Zoology at Harvard University, as well as Arthur C. Bent's books on birds, in paperback.

To see our native animals in world perspective or to check on exotics, we rely upon the "World of Nature" series: *The Living Birds of the World* (1958), by E. T. Gilliard; the *Reptiles* (1957), by K. P. Schmidt and R. F. Inger; the *Amphibians* (1961), by D. M. Cochran; the *Fishes* (1961), by E. S. Herald; the *Insects* (1959), by A. B. and E. B. Klotz; and the *Lower Animals* (1960), by Ralph and Mildred Buchsbaum and the two Milnes. We find many answers on birds in the complementary giant volumes *Birds of the World*, by O. L. Austin, Jr. and Arthur Singer (1961), and *The World of Birds*, by James Fisher and Roger Tory Peterson (1964). An authoritative reference on mammals is Ernest P. Walker's 2-volume *Mammals of the World* (1964), which illustrates and discusses every genus.

For pocket-sized books on the animals of the United States and Canada, we regard highly the "Golden Nature Guides," edited by H. S. Zim. They are up to date, full of color and facts, and include *Reptiles and Amphibians* (1956), by Zim and H. M. Smith; *Fishes* (1956), by Zim and H. H. Shoemaker; *Pond Life* (1967), by G. K. Reid; *Seashores* (1955), by Zim and Lester Ingle; and *Sea Shells of the World* (1962), by R. Tucker Abbot and Zim. R. Tucker Abbot wrote his own larger book, *American Seashells* (1954), with more detailed information. Large, handsomely illustrated, and full of facts to delight a fisherman, *Fish and Fishing*, by Maynard Reece (1963), deals with North American fishes of special interest.

For aquatic animals, we need to remind ourselves frequently of fundamental facts about the wet world they inhabit. We go to the standard volumes: *The Oceans*, by H. U. Sverdrup, M. W. Johnson, and R. L. Fleming (1942); and *The Life of Inland Waters*, by J. G. Needham and J. T. Lloyd (3rd edition, 1938). Identification of aquatic animals is convenient with *A Guide to the Study of Fresh-water Biology* by J. G. and Paul R. Needham (5th edition, 1962), which has helpful keys and illustrations, yet is a slim paperback. More ponderous and complete are *Freshwater Biology*, edited by W. T. Edmondson (2nd edition, 1959), and the somewhat lighter *Fresh-water Invertebrates of the United States*, by R. W. Pennak (1953). We wish *Field Book of Seashore Life*, by Roy Waldo Miner (1950), could be brought up to date and improved in many ways, but it is the only identification guide we can find for the animals of tide pools and beaches along the American Atlantic coast.

For a very long while in the past, the whole living world was marine. The changes in the marine environment and its animals from the past to the present are described in two thick volumes we refer to often. Published as Memoir 67 by the Geological Society of America (1957), they bear the forbidding title *Treatise on Marine Ecology and Paleoecology*, and are edited by J. W. Hedgpeth (Vol. 1, *Ecology*) and H. S. Ladd (Vol. 2, *Paleoecology*). Far easier to carry is the "Golden Nature Guide" on *Fossils* (1962), by Rhodes and Zim.

The zoologist who is concerned with live animals, as we are, can never long forget that unless animals eat other animals, they eat plants and show a definite preference for certain kinds. To help us tell plants apart, if only to recognize what the animals are eating, we depend (in the northeastern quarter of the United States and adjacent Canada) on the most recent edition of *Gray's Manual of Botany*, as revised by M. L. Fernald (8th edition, 1950). For the whole world, we take from our shelf a fine summary of genera in almost all families, *Plant Taxonomy*, by Earl L. Core (1955). Some of the more romantic, esthetic, and historical aspects of plants delighted us so much that we wrote them into our *Living Plants of the World* (1967). Many of the plants have developed adaptations matching those of the animals that eat their leaves, pollinate their flowers, or bury their fruit.

The study of animals in relation to other animals, to plants, and to the non-living environment may be two-sided and be called ecology, or one-sided and called animal behavior. In both aspects of zoology, enormous strides have been made recently, in-

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troducing new ways to look at old facts and new terms with which to describe them. In the "Life Nature Library" we have two excellent nontechnical summaries of these fields: *Ecology* (1963), by Peter Farb, and *Animal Behavior* (1965), by Niko Tinbergen, both with the editors of *Life* and outstandingly illustrated. This is the same Peter Farb whose book *Living Earth* (1959) gives us, in 173 pages, more of the information we want about living things in the soil than can be found in 770 pages of The Yearbook of Agriculture for 1957, entitled *Soil.* As a delightful and stimulating short account of modern tropical ecology, we read from our copy of Marston Bates's book *The Forest and the Sea* (1960), comparing the stratification of animals in a rain forest and a coral reef.

Two books we treasure as accounts of animal behavior were translated into English from German and still read like the classics they are: *King Solomon's Ring* (1952), by Konrad Z. Lorenz, with his own charming ink sketches, or in paperback (1961), and *Bees: Their Vision, Chemical Senses, and Language,* by Karl von Frisch (1950). More recent volumes, many of them equally slim, bring the subject to date and into quantitative form. We like *Behavioral Aspects of Ecology,* by P. H. Klopfer (1962), because it attempts to answer the important questions: Why don't predators overeat their prey? How are space and food shared? Why are there so many species? How do species remain distinct?

Back in 1956, zoologists welcomed a tabulation of measurements in a compilation entitled *Handbook of Biological Data.* Within eight years, the Federation of American Societies for Experimental Biology sponsored a new volume *Biology Data Book* (1964). compiled by P. L. Altman and D. S. Dittmer, which replaced the *Handbook* in their biological series. It is already getting behind times. The 60 (out of 633) pages dealing with environment and survival are brief and incomplete by comparison with the 1966 volume in the same series, *Environmental Biology,* with more than 600 pages of tables. They draw together and cite references to research through 1965 on the effects on animals (and some plants and microbes) of temperature, radiant energy, sound, vibration, impact, acceleration and gravity, atmospheric gases and pollutants, changes in atmospheric pressure, other gases, water and solutes, and biological rhythms. Much of the information relates to man. and includes discoveries made in orbiting space capsules. As modern as today, it will need expansion tomorrow.

Konrad Lorenz framed by the loving goslings who accept him as their "mother." From "Animal Behavior."

When we feel pressed by all the ew subdivisions of zoology and the evelopment of fresh understandings n each, we are likely to set aside the ort-lived new books on molecular enetics, on events in organelles isible only through the electron icroscope, and relax with comfortble books written in less technical yle. We savor the old literature: ristotle (in translation), Gilbert hite, Henry Thoreau, Alfred Rusl Wallace, Charles Darwin, William artram. We're happy that Robert ooke's *Micrographia* (1665) has een revived in paperback, letting us view his other discoveries through e of the first microscopes. Closer the present, we enjoy the prose, e vivid descriptions and enthusims of William Beebe, Donald Culss Peattie, and Aldo Leopold. We ck up books by Hal Borland, John ieran, Joseph Wood Krutch, Sally rrighar, Edwin Way Teale, to eny the outdoors with them.

We go back into the past with ren Eiseley and George Gaylord mpson. We delight again in an agined walk with Rachel Carson rereading *Under the Sea-Wind* or *e Edge of the Sea*. Both of these oks hold, for us, more of her sense wonder than did her popular *The a Around Us*.

We can still journey up the Aman with Henry Walter Bates, explore icaragua as it used to be with omas Belt, roam the Argentine pampas with W. H. Hudson, or walk the dunes on Cape Cod with Henry Beston. After a while, we are ready to look at the world through the eyes of modern zoologist-traveler-authors in our copies of the big volumes in the "Continents We Live On" series: *Europe* (1964), by Kai Curry-Lindahl; *Africa* (1965), by Leslie Brown; *South America and Central America* (1967), by Jean Dorst; *Australia and the Pacific Islands* (1966), by Allen Keast.

Then back we go to the most recent issues of the zoological journals and the natural history magazines, to see what meaningful molecule has been deciphered, what mathematic model has been invented to represent an owl catching a mouse, what expedition has just returned with special trophies, what extinct bird has reappeared, and what new books are to be read.

Lorus and Margery Milne are professor of zoology and lecturer in nature recreation, respectively, at the University of New Hampshire and the authors of over twenty books on zoology.

THE TIDES, by Edward P. Clancy. *Doubleday & Co., $4.95; 228 pp., illus.*

As a teacher and lecturer in astronomy, navigation, and physical oceanography, I have often experienced the challenge, pleasure, and frustration of describing the tides, explaining the physical basis of the tidal force, and explaining how theory can contribute to an understanding of the complex pattern of tides. This book by Edward P. Clancy has been written for an audience of precisely the kind I have faced very often, and by an author who has undoubtedly shared my experiences with the problem. He and I think alike on the subject, and he has shown me, through this book, many insights that will affect my teaching in the future.

Every teacher or lecturer on earth science who is called upon to discuss the tides should read this book. Many students, on the senior high school and undergraduate level, should be referred to it. Dr. Clancy nicely balances his presentation between the astronomical phenomena that produce and modify the tidal effect, the physical environment of the earth that modifies the tidal force to produce the variety of tides we observe, and a description of interesting tidal phenomena, their implications and effects, and their relation to theory. The approach is rigorously logical, although mathematical data are kept to a minimum. Appropriate line sketches are used liberally

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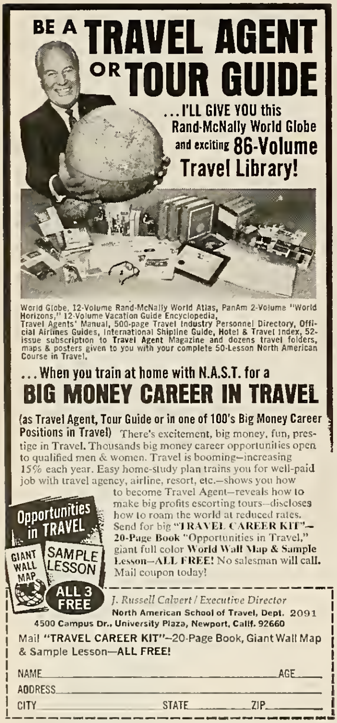

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throughout the text to illustrate the logic of the narrative. I would have preferred that some of the illustrations be located more closely to the text to which they relate. It would make for easier reading if we did not have to turn pages in order to follow the examples illustrated.

While mathematics are limited, the language of the book sacrifices nothing to popularization. The author respects the efficiency of using the right words in the right places. However, since the terminology of the tides is drawn from many sciences, a glossary of terms might have been valuable in the appendix. This is especially true since it is presumed that the book will be used as a teaching aid or a study reference by many not expert in the field.

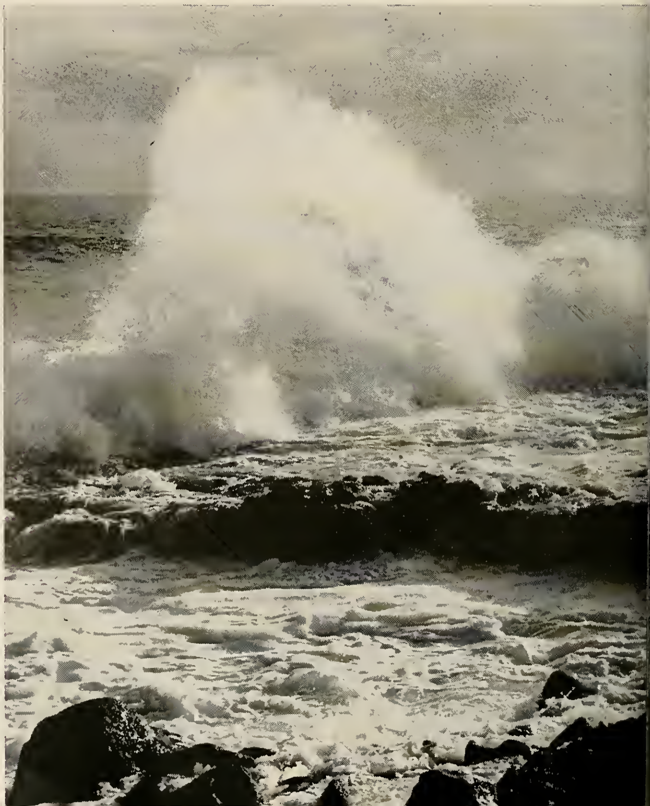
I regret that the author found it expedient to use the term centrifugal force in his explanation of tidal theory. While he certainly knows—and his text clearly illustrates this—that the centrifugal effect can be adequately described by using other terms, I wonder if he has encountered the sometimes rabid proponents of a quite different "centrifugal force theory" in explaining the tides? I have, and I hope that those who hold to it will not try to find refuge in Dr. Clancy's use of the term in his explanation. They should not, for it is not there.

Written and published as part of the science series that grew out of the Physical Science Study Committee, *The Tides* is a comprehensive review of the origin, effect, and variety of tidal forces and effects experienced on earth. It includes a discussion of tides in small bodies of water as well as in the oceans, tides in the solid earth, and tides in the atmosphere. It should be a most useful survey of this subject for students and teachers alike.

THOMAS D. NICHOLSON
The American Museum

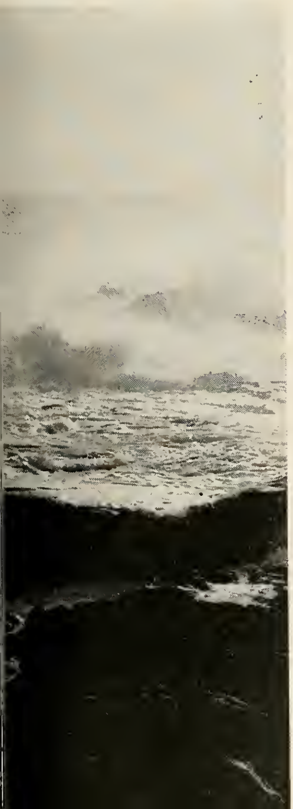
GALÁPAGOS: THE FLOW OF WILDNESS, photographs by Eliot Porter, text by Loren Eiseley. John P. Milton, and Eliot Porter, edited by Kenneth Brower. *Sierra Club Books, 2 vols., $55.00; 320 pp., illus.*

In these two tall volumes the enchanted isles of Spanish and buccaneer tradition are brought to us as never before by the incredibly beautiful photography of Eliot Porter. There are 138 color reproductions, of sizes up to 12 by 16 inches, almost uniformly perfect in composition, depth of focus, and what the French call *ambiance.*



Galápagos landscape and vegetation, e surrounding sea, and the native ani- al life are Porter's subjects. The tterns of lava flow; the eerie forest cactus, palo santo, and bromeliads; e gigantic tortoises that look every y of their two centuries; the iguanas the land and of the ocean are all re, together with crabs, fur seals, sea ns, porpoises, and green turtles. And ere is a strange aggregation of birds, cluding warblers, Darwin's finches, rmilion flycatchers, owls, buzzards, lls, ducks, flamingos, petrels, alba- osses, boobies, frigate birds, pelicans, ghtless cormorants, and penguins. ey all look not only completely at me but also unaware of any human esence, as each goes about its feed- g, brooding, or other business. To nk the pictures would be almost out the question, but if you will look at e conclave of sixteen or more Hood land mockingbirds, or at surf pound- g the ledges of Sombrero Chino, you ll never forget such photographs. e latter, the most magnificent por- ayal of froth and thundering surge at could be imagined, was made by orter's son, Stephen.

Wild surf pounds the ledges of Sombrero Chino. From the book ;alápagos: The Flow of Wildness"



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Overseas Nature Tours

— 1969 Program —

Here is a summary of our 1969 program. Space permits only brief mention of each tour, and one should, by all means, have the "Tour Catalog" with thumb-nail sketches of each trip. Early registration will save disappointment, and may be made tentatively. North America tours 2 wks., remainder of the world 3 weeks each, except as otherwise noted.

— NORTH AMERICA —

FLORIDA: Wild portions of the State from Tallahassee to Key West. Jan. 11.

TEXAS BIRDS: Whooping cranes, Rio Grande reserves, Northeast Mexico. March 15.

TEXAS WILDFLOWERS: Separate wildflower group on above route. March 15.

ARIZONA: Popular bird tour of southeast Arizona under Dr. Robert Ohmart of University of Arizona. April 26.

CALIFORNIA: North-with-spring in parks, mtns. & off-coast islands. May 10 (3 wks.)

CASCADES: North through Oregon and Washington reserves and parks. May 31 (3 weeks.)

ALASKA: Three successive 2-wk. trips: (1) The inside passage and Yukon; (2) the central region with McKinley Park, Kenai, Kodiak and Katmai; and (3) outposts of the Aleutians, Pribilofs, Nome, St. Lawrence . . . Island, Kotzebue and Point Barrow. Series begins at Seattle June 21.

Note that the last 5 tours may be taken in continuous succession, following spring north in one great 12-week trek from the Mexico border to Point Barrow on the Arctic.

— MIDDLE AMERICA —

CENTRAL AMERICA: Feb. 8-14. Guatemala, Salvador, Honduras and Nicaragua. Tropical birdlife and botanical highlights.

COSTA RICA: Feb. 15-28. Itinerary carefully examines in sequence the five faunal regions.

Note that Yucatan, Panama and Colombia are done twice a year in a continuous chain, affording a 7-week view of the bird and plant life of tropical America that is both memorable and economical. In 1969 this series starts Jan. 11 and July 19.

— SOUTH AMERICA —

COLOMBIA: World's top bird country. Two 1969 departures: March 15; Aug. 16.

ECUADOR-PERU: Heavy bird populations of jungles & high Andes, including Machu Picchu and upper Amazon. Sept. 6.

CHILE-ARGENTINA: Highlights of both coasts, plus Tierra del Fuego. Sept. 27.

BRAZIL: Iguasu Falls, the Rio coast, central jungles and the Amazon. Oct. 18.

GUIANAS-VENEZUELA: The 3 Guianas, Trinidad and highlights of Venezuela. Nov. 8.

The 5 South America tours, starting with Colombia on Aug. 16, readily combine into a remarkable grand tour of the continent.

— EUROPE —

By all means obtain the detailed announcement of our 11-tour 1969 Europe program, with its many possible combinations. See opposite column for additional information.

— AFRICA, ASIA, ETC. —

SOUTH AFRICA: This popular trip departs July 24, includes S.W. Africa and the Kalahari.

EAST AFRICA: Extremely heavy bird concentrations, many big mammals. August 14.

CENT. AFRICA-MADAGASCAR: New and promising, beginning at Victoria Falls Sept. 4.

JAPAN: Full-time birding from south tip of Kyushu to north end of Hokkaido. Optional extra week for tourist objectives. Aug. 2.

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But the artistry of Eliot Porter is not restricted to magic with his camera. The second volume contains his narrative of three months in the Galápagos. This runs to more than thirty thousand words, which I find to be the most informing general scientific record ever made at the archipelago. The birth of the islands from volcanic depths, the source of their life, the behavior of the plants and animals, are acutely comprehended and simply and vividly described. Porter writes calmly and objectively, with the insight and flair of half-forgotten Alexander von Humboldt, and when on occasion he becomes subjective it stems wholly from the environment and is illuminating and frequently whimsical. I thought at one point that his account had reached its dramatic climax with the ascent to the high crater of Fernandina (Narborough)—but that was before I read on.

The plan of the book is admirable, one volume being called *Discovery*, the second *Prospect*. The text begins with a letter written in 1535 to the Spanish sovereign by Fray Tomás, whose party was the first to sight and land and "say mass" upon the Galápagos. Then follows a note by David Brower on the Sierra Club Expedition. A masterly introduction by Professor Loren Eiseley subtly states the momentous questions that the young Darwin asked himself at the islands. The reader is allowed to deduce the correct answers. Eiseley also writes about the slightly later visit of Herman Melville, as a seaman, to the island cluster, which, from the standpoint of the historian of ideas, is actually the most famous group in the world. Records of corsairs, whalemen, naval officers, and scientists follow, with liberal quotations from Dampier, Davis, Morrell, Darwin, Melville, Slevin, and Beebe.

The book ends with a series of Galápagos sketches by Kenneth Brower, telling of a sadder latter day in Eden, when a handful of hardy immigrants have come to stay. Plants, such as coffee, have been brought to Santa Cruz Island, where they run rampant as weeds and crowd out indigenous vegetation. The giant tortoises, which once numbered hundreds of thousands, so that a man could cross a mountain meadow from back to back, like stepping stones in a stream, are now reduced to mere thousands; on many islands all are gone forever. Cattle, burros, goats, dogs, cats, pigs, and rats have been introduced and have gone feral and multiplied at the expense of the helpless native animals.

Whether mankind can save what remains is a question left moot. Conservation of the highly adapted Galápagos life has been neglected at least a century too long and only a minute proportion of *Homo sapiens* has the wisdom to comprehend it.

Robert Cushman Murphy
The American Museum

Lives of Social Insects, by Peggy Pickering Larson and Mervin W. Larson. *The World Publishing Co., $6.50; 226 pp., illus.*

The Larsons have done it again. A few years ago Peggy Larson, a librarian in Tucson, and her husband Mervin Larson, curator at the Arizona-Sonora Desert Museum, produced a book called *All About Ants* that is, by all odds, the best popular account of those wonderful insects. Their new book covers not only ants but also social wasps, bees, and termites. Like their earlier book, it is carefully researched, up to date, and written in a lucid and attractive style. The photographs are uniformly excellent and to the point; they do not seem to be credited, so I assume they are the work of the authors. This book should be in every school and city library as wel as on the shelves of every person no so glued to his TV set that he has los contact with the world of reality.

Since this book is based on a study of current literature, it is not surprising that it reflects some of the contradictions in that literature. For example the authors state that distance to a food source is indicated by a honeybee by differences in speed of a dance cycle which "may sometimes amount to only 0.05 second"; yet (according to Adrian Wenner) "the bees may not use thi particular information." The Larson discuss the fossil *Uralotermes permianum*, but this has been discredited a a termite, and the oldest member o that group has just recently been described from the Cretaceous era, les ancient than the record cited by th Larsons by something like 100 millio years. But on the whole, I am amaze at how well the authors have succeede in presenting a clear and accurat summary of a field not always note for clarity of thought and presentation

I do feel that a book as stimulatin as this, addressed I assume to all curious persons of high school age and beyond, should provide the reader wit suggestions for further reading. Som of the books and articles by Karl vo Frisch, Martin Lindauer, Charle Michener, E. O. Wilson, and others are highly readable and provide insights into the scientific process tha a survey such as this cannot convey.

Studies of the origin of insect soc ality, of intracolony communicatio and of basic insect behavior are proceeding in many laboratories at th present time, and the field is provin more complex and less amenable t

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generalization than once supposed. We may expect exciting progress in this field in the future, and we should be grateful to the Larsons for presenting so excellent an introduction to the subject at a time when it is much needed.

HOWARD E. EVANS
Harvard University

TREES, by Andreas Feininger. *The Viking Press, $22.50; 116 pp., illus.*

This is a big book. It measures 12¾ inches by 10¼ inches, is 1¼ inches thick (including the cover), and weighs more than four pounds. The dust jacket has a striking photograph of a bristlecone pine that may be several thousand years old. The book has a list price of $22.50. I fear that the publisher has programmed it for Christmas sales as a coffee table item, and this would be a crying shame for it is a very good book.

Andreas Feininger has an international reputation as a photojournalist with a long list of credits in *Time*, *Life*, and other periodicals. As those who have followed his work know, he is a meticulous craftsman, noted not only for his picture impact but also for the crispness of his photographs. Happily these characteristics are to be found in the generous number of color and black-and-white photographs of trees that form an integral part of the text.

Now to the text. Like all professional plant scientists, I was prepared to snicker at the errors that frequent the amateur's attempt to present botanical information to the interested public, but I found very little to curl my lip. Feininger's exposition of, say, photosynthesis, normally a difficult subject, is accurate and well handled. This is generally true throughout the book; the errors of fact are rare and minor.

A section by section outline of *Trees* is unnecessary. The author covers economic, social, ecological, and historical aspects of trees as individuals and as populations. He discusses the gross and microscopic structure of tree parts, and blocks out the functions of the organism and its parts, all in a sprightly and non-gushy fashion. Pervading the text and the pictures is a deep love of life and of living things presented in a calm and mature way. His concluding plea for an intelligent national approach to conservation is appreciated. I regret only the absence of more explanatory line drawings.

I recommend that *Trees* be read first, followed by Menninger's *Fantastic Trees* (reviewed in NATURAL HISTORY, May, 1967). Both are on the same type of plant, both are excellent in content and format, and both are delightful reading—but how different they are!

RICHARD M. KLEIN
University of Vermont

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For eight years we have been organizing group trips to investigate the natural history of Europe, Africa and the world. See summary of world program in opposite column. Below are details of groups now forming:

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— SOUTH AMERICA —

Feature for the Fall of 1969 is a series of 3-week tours circling South America, starting Aug. 17 in Colombia and swinging counter-clockwise around the continent. We'll go as far south as Tierra del Fuego, touch all the famous bird observation highlights of the Andes and both coasts, and end in Venezuela before Xmas. See dates in opposite column, and let us send you the itineraries.

— EUROPE —

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EUROPE SOUTH covers France's Camargue and Riviera, Switzerland's birds and alpine flora, famed Neusiedlersee on the Hungary border, and the Rhine country; May 8. **EUROPE NORTH** takes in northern Germany and covers Sweden fully to and beyond the Arctic Circle; May 29. **NORWAY.** our most popular of all, covers fjords, mountains and coastal islands in an itinerary that has become famous; June 22. These 3 tours combine into a memorable journey "north with the spring" from the Mediterranean to North Cape and the Arctic.

MEDITERRANEAN begins at Lisbon, visits Spain's famed Coto Doñana, France's Camargue, Corsica and northern Italy; May 8. **BALKANS** starts at Venice, visiting bird and botanical highlights of Yugoslavia, Greece, Turkey, Romania and Hungary; May 29. **U.S.S.R.** starts from Prague June 22, covers natural history highlights of Poland and Russia. **SIBERIA** is a 3-wk. link in an economical round-the-world route; the Asian U.S.S.R. republics, Lake Baikal and a journey into Outer Mongolia are features; July 13. These 4 tours combine into an extraordinary nature experience.

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July 9th to August 11th, 1969

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Contact With the Stone Age

Continued from page 18

Mauritia palm. The old woman in the hut adjacent to ours did not even hang a hammock, although she had three of them. She squatted by her fire all through the night watching us. Her only move for more than eight hours was to reach out and push the wood farther into the fire as it died down. Others were up and down all during the night, moving from their hammocks to the fireside to straighten arrows. At all times their weapons were within their reach. We had two guns with us, which we had tied securely into the top of our hut. Most of us had also carried machetes, and these, too, we had secured in the thatch of our huts, but somehow, during the time that we were there they had managed to steal several of them. We felt it more prudent not to try to stop it but let it go unnoticed. The night passed without incident.

Just before dawn, several of the men came to our hut bringing us little pieces of pig meat and skin. Again we took this as a good sign, but they told us that we must leave. They, too, were going to leave as soon as we were on the way. We talked and traded a bit more, giving beads, pocketknives, and steel arrow points for fans, combs, pottery, arrows, etc. I traded my new Wayana hammock for one of their hammocks. The lady happily took the white cotton hammock, dropped it in the dirt and mud at her feet, and scuffled her toes in it. One of the Trio women showed her that it should be kept up out of the dirt. The Trios gathered them all together again and sang for them for about fifteen minutes, told them something of God who had created all the things in the bush about them, and showed them books. The old chief commented that God must really be good. He said he knew nothing about Him, and that he had to leave now to get arrow cane. He said the books seemed good to him, that he was not afraid of them, and that someday he wanted to know more about them. With this we took our leave of the people and filed out into the swamp and the long trail back to

In and Out of the Field

Continued from page 8

they are everywhere this time of year. It was of great comfort to know that, among many of his other accomplishments, the new president of The American Museum of Natural History has produced an outstanding book on the shorebirds of North America.

Last summer, while on an Explorers Club expedition in Surinam, we were able to meet and spend part of a day with Ivan Schoen at his mission post in Apetina, where he regularly works among the Wayana Indians. We arrived on Sunday and were led to a huge, circular thatched hut at one end of the village. There, from a small lectern, and in the language of the Wayanas, Mr. Schoen—crew cut and wearing sneakers and khaki trousers—conducted an afternoon religious service. The Indians, in their brilliant red loincloths, sat quietly around him, responding in unison every now and then when Mr. Schoen paused and looked up from his reading of the Scriptures (which he had translated into Wayana). Despite the strangeness to us of the language, and of the Indians themselves, and despite the improbability of our sitting there at the edge of a rain forest in a small village on a Surinam river, there was, perhaps in the way the sunlight filtered through the hut or in the hum and cadences of prayer, the unmistakable hush and flavor of Christianity.

Peter Matthiessen's name must now come up again, if tangentially. His novel, *At Play in the Fields of the Lord*, is about missionaries, soldiers of fortune, and Brazilian Indian tribes. This month, NATURAL HISTORY publishes an account of Ivan Schoen's contact with the Wama, a Stone Age tribe in Surinam. Some of the conflicts explored in the novel—conflicts that many anthropological and Peace Corps workers undoubtedly have wrestled with—deal with the integrity of indigenous cultures. What *are* the ethics and techniques of contacting "virgin" peoples? Fifty years ago no one but anthropologists would even have asked such questions. Today they are rapidly becoming academic, since there are probably very few such tribes left. Still, the questions are fascinating. Ivan Schoen, for his part, has proceeded ır canoes on the Waremapankreek. he trip out took more than five ours, and though tiring, it was with- it event.

fterthoughts and Future Plans.

It is our firm conviction that any experienced person endeavoring to iter this tribe will be both placing s life in jeopardy and will no doubt the cause of these people disap- earing again into the far reaches of e Surinam interior. Besides this, we e very concerned that unqualified ersons will only succeed in carrying fatal diseases, which could, in a w weeks time, completely wipe out is tribe of people for whom so many ive sought for years. Then too, there e those who, for monetary gain, ill dispense with all discretion in der to photograph and exploit these rimitive, Stone Age individuals.

We request therefore, for the sake f this tribe of people, and based on the experience we have had with idians and the medical work that we ave carried on among them, that our mission be granted exclusive permission by the government of Surinam to supervise and direct at least these initial contacts with this tribe. Of paramount importance is to get them innoculated against the devastating diseases of the outside world and have adequate medical care available for them to cope with the sicknesses that are inevitable. We also advise a very gradual approach, using the most trustworthy Trio and Wayana Indians in every future contact. Our plan would be to place several Indian families among them and one of our Trio tribal workers. It is evident that these people do not have a regular village. They do not cultivate anything and must move continually in search of fruits, nuts, and meat by which they exist.

We are happy to share with you this report of our first contact with these Indians. . . .

Signed/Ivan L. Schoen
Ivan L. Schoen
Interior Coordinator
West Indes Mission

ith tact and with great sensitivity. 'e also seems to be appropriately ware of the hazards of exposing ie Indians to the diseases of the utside world. But their way of life ill now change—a great pity since iey appear to be genuinely Neo- thic—and many ethnological ques- ons will have to pass unanswered. Iow efficient, for example, is the one ax? Michael Harner, an anthro- ologist at Columbia, proposed this uestion when we told him about the iissionary's report. Subsequent to iat discussion, we received a letter rom Surinam, saying that in trail- ıg the Indians it was now possible detect, from the way they cut their ay through the forest, that they were sing *steel* machetes stolen from the iissionaries. Out of the Neolithic, ito the Recent—rarely is a moment f such profound change so visible.

The famous Okefenokee Swamp in 'eorgia and Florida has given up ome of its last secrets. Word comes rom the Geological Survey that, with ie aid of a new "photomap" tech- ique, the swamp has now been iapped in its entirety in considerable detail. The cartographers have combined aerial photography with conventional mapping symbols to produce a map that shows all of the swamp's 700 square miles. The technique makes it possible to "spot individual trees . . . and to make distinctions between pine trees growing on land and cypress trees and bushy growths in the swamps." Imagine. Anyone can now get a complete set of maps of Okefenokee for only $8.00. We remember, as a youngster, reading, and hearing over the radio, lurid stories of the limitless reaches and grotesque occupants of "dreaded Okefenokee," and are, frankly, a little sorry it is so thoroughly mapped. But have the cartographers now mapped all there is to map? Not likely. They are like the people who paint bridges: when they're done, they start over. But they start over with improved techniques that can detect more subtle elements in the landscape, which means a better ability to monitor changes in the landscape, which means there is a continuing need for new maps. If one could get all this sufficiently unraveled, one could see in the world of map making, a kind of Parkinson's Law at work.

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Letters to the Editors

Mineral King

Our thanks to Jack Hope for an excellent article on magnificent Mineral King (NATURAL HISTORY, Nov., 1968). His explanation and analysis of the complex history of the Mineral King development is hopefully a contribution toward improving the processes which led to such a misappropriation of public land. He forgot to mention explicitly, however, that the decision to develop Mineral King was made unilaterally by the Forest Service with no public hearings or other opportunity for public comment.

The Forest Service was apparently enamored or overwhelmed by the Disney and other bids, which were several times the size anticipated. The project is clearly too big for the little valley. Perhaps some comparative measures would bring into focus the Disney error in concept.

The 1,700 rooms which Mr. Hope mentioned add up to a sizable volume. The largest hotel in Los Angeles is the 1,500-room Biltmore; the 11-story Disneyland Hotel has only 608 rooms. The ten restaurants would seat 4,500 guests at one time. Finally, compare Yosemite Valley and Mineral King. The latter is 1½ miles long and approximately ¼ mile wide, while the former is 7 miles long and 1 mile wide. Yosemite is heavily forested, Mineral King only lightly wooded. Even before it reached the level of two million annual visitors, Yosemite was infamous for its crowded condition. Yet the Disney Corporation expects to attract about the same number of people to the little valley of Mineral King. Does that make sense?

Proponents of the project consistently claim that the development would make Mineral King accessible. It is accessible *now* to anyone who cares to drive there. Moreover, what is accessible about a big, expensive resort? One Disney brochure said they would have "medium to *luxury* priced accommodations." How many families can afford the daily expenditure of $25 per person which the developer expects?

Keep the articles like Hope's "The King Beseiged" coming. If something isn't done soon, all naturalness will be history.

JOHN W. RETTENMAYER
Los Angeles, Calif.

The Disney Position

Walt Disney Productions welcomes this opportunity to comment on your thoughtful article concerning the decision of the United States Forest Servic to develop Mineral King as an all-yea recreational area.

Certainly, the balanced use of publi lands is a major issue confronting s ciety today, and no one in governme has given more thoughtful consideration to the management of these valuable assets than has United States Ser ator Thomas H. Kuchel. As a senio member of the Senate's Committee o Interior and Insular Affairs, he was a author of the bills creating the Redwood National Park and the Poin Reyes National Seashore.

In commenting on the Mineral Kin Development, Senator Kuchel has written as follows:

"Opponents of Mineral King raise legitimate question of whether the valley's present wilderness-like conditio is a more important public resourc than would be the recreation opportunities resulting from its development With our nation's wilderness eve shrinking, we have a solemn duty t consider this question whenever it i proposed that the character of wilderness be altered. As a cosponsor of th Wilderness Act of 1964, and as th Senate author of the first addition t our nation's wilderness system unde that Act. I am especially sensitive t that obligation.

"Mineral King is . . . surrounded by wilderness-like country, but it does not qualify as wilderness itself. There is a road into its very heart. A mining road into Mineral King was built in the 1920's. It has since been improved to serve dozens of summer homes, an old resort and other improvements in the valley. The existing road alone disqualifies Mineral King for inclusion in the Wilderness System under the 1964 Act.

"The possibility of adding Mineral King to Sequoia National Park was studied when the boundaries were expanded in 1926. However, Mineral King was not proposed for inclusion in the park because mining and improvements in the valley were inconsistent with National Park objectives.

"The demand for suitable winter sports sites has increased dramatically during the last few years and will continue to grow. But areas suitable for winter sports development are extremely limited. Most have already been developed. This need is particularly critical in California where, according to a recent study, 35 per cent of all skiers in the nine western states now live.

"We must make balanced judgments on whether any given resource should

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be developed commercially, developed for recreation, or maintained in its natural state. These are difficult judgments for which there are all too few guideposts. But if we fail to allocate a balanced portion of our total resources to each of these needs, sheer economic and demographic pressures will lay waste to the remaining wilderness we possess.

"People will continue to go to the mountains. There is no way to stop them. Indeed, why should we try to stop them? Is it not far better for their government to help set aside specific and suitable areas for their enjoyment and recreation? If we fail to develop selected areas, such as Mineral King, the 50 million people who will be in California before the end of this century will spill over the sides of the coastal cities and ravage the Sierra with unplanned and undirected enthusiasm for the vanishing outdoors.

"The best assurance that we will permanently protect portions of our natural heritage lies in orderly development to accommodate the demands of our growing population to be near nature.

"In Mineral King, California has an outstanding opportunity that should not be lost. It is a spectacularly unique area which, if carefully planned, can be developed into one of the finest recreation complexes of the world."

The responsibility for careful planning, as mentioned above by Senator Kuchel, now rests with Walt Disney Productions, which, in 1965, was selected to develop the area under the administration of the United States Forest Service.

We have placed our substantial creative talents and reputation for quality recreational developments behind the master planning of this project. In a few months, when these plans have received final approval from the Forest Service, we hope you will review them carefully to reassure yourself and your readers that every possible consideration has been given to preserving the aesthetic values and protecting the capacities of the area. You will find that the concept of our facilities pictured in your article is substantially in error and that it has been greatly improved since we began our on-site investigative efforts.

It is our hope that Mineral King will become a prototype and a standard of excellence for all outdoor recreational centers of the future.

Robert B. Hicks
Mineral King Project Manager

Writer Replies

The letter from Walt Disney Productions quotes from an article by Senator Thomas Kuchel in *Western Ski Time* magazine (October, 1967). The exsenator notes that "Mineral King . . . does not qualify as wilderness . . . because of the "improvements" that have been made there. (The resort he refers to, by the way, is a 2-room general store and post office, pictured below.) Bu since the road, summer cabins, and other structures occupy less than 10 per cent of the land area in Mineral King Game Refuge, and since over 90 per cent of the refuge remains truly wild and natural, it appears that justification of the Disney resort on the basis of the non-wilderness argumen could be termed a rationalization.

There seems to be some difference o opinion as to why the Mineral King area was not added to adjoining Sequoia National Park in 1926. In any event, my guess is that today, the Park Service—if given the opportunity– would gladly accept Mineral King as a 15,000-acre gift from the Forest Service (the agency that now controls it) and would certainly find this move in keeping with its 1969 objectives.

Although I am not sure what i meant by a "balanced judgment," will agree that "there are all too few guideposts" for making decisions relating to our natural environment, o for predicting the nature of our dependence upon that environment on hundred years from now. However, th substitution of political guideposts fo ecological ones doesn't strike me as realistic approach.

One of the widely publicized statistics of the American outdoors is tha 95 per cent of the human traffic withi our national park system occurs in onl 5 per cent of the total parkland—within, or immediately adjacent to, th formal campsites, visitor centers, wel marked trails, hotels, and other "deve oped" portions of the parks. Wild regions are lightly used. Since most of u are reluctant to stray more than half mile from the steel wombs of our automobiles, there seems to be little dange that California's wilderness will b

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The contest is strictly for amateur photographers. Everyone is ble except employees of Natural History or of The Ameri- Museum of Natural History, members of their families, and viduals who personally, or any members of whose families, engaged in the manufacture, sale, commercial finishing, or essional use of photographic goods.

No negatives should be submitted. Entries must be post- ked no later than March 15, 1969. IMPORTANT: No more n one picture may be submitted by any one entrant.

Color photographs:
a. Color pictures may be submitted as either a transparency or a print.
b. Transparencies must be originals and must be mounted in cardboard only.
c. Color prints must be no more than 8x10 and unmounted.
d. Transparencies and color prints will be returned to entrant only if accompanied by a self-addressed envelope of proper size, bearing sufficient return postage.

Black-and-white photographs:
a. Photographs must be submitted in print form, 8x10, and unmounted. DO NOT SUBMIT NEGATIVES.
b. Developing and printing may be done by a photofinisher or by the entrant. No composite pictures such as multiple printing or montages are eligible. No artwork or retouching on prints or on negatives from which they were made is permitted.
c. No black-and-white prints will be returned.

5. On the back of each print or on the transparency mount must appear: name and address of the photographer, description of subject, where and when taken, and make and model of camera.

6. Natural History assumes no responsibility for prints or transparencies.

7. Pictures will be judged on photographic quality and originality in choice and treatment of the subject. The decision of the judges will be final.

8. Before receiving a final prize, the entrant must sign a statement that his picture, or any closely similar picture of his of the same subject or situation, has not been, and will not be, entered in any other photographic contest without the permission of Natural History, and has not been and will not be offered for publication in any manner prior to July 1, 1969. Natural History retains first publication rights to winning pictures.

9. Natural History reserves the right to use any or all of the winning photographs in a special exhibition at The American Museum of Natural History or for subsequent exhibitions, and to utilize any of the winning photographs for publicity purposes in these connections. All prints exhibited will become part of the permanent collection of The American Museum of Natural History.

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DEADLINE FOR ENTRIES: March 15, 1969

ravaged "with unplanned and undirected enthusiasm . . ." unless high-speed highways are thrust into it, as is planned at Mineral King.

To what extent have the "demands of our growing population" been taken into consideration in the planning of the Mineral King resort? One need go but a short distance from Senator Kuchel's home town of Anaheim, the site of Disneyland, to discover a real need for recreational facilities among the immobile ghetto population of Los Angeles. Perhaps the altruism and working capital of the Mineral King proponents could be put to better use nearer home.

Finally, it appears that the best means of preserving our natural heritage does not lie in "orderly development," for by definition, development eliminates naturalness. Rather, the only answer—if one truly exists—seems to lie in the direction of population control. But that is another story.

JACK HOPE

Author vs. Reviewer

Professor Elman Service's review of my book, *The Rise of Anthropological Theory* (December, 1968), fails to meet established standards of professional criticism. He asserts that my treatment of cultural evolutionism is, much to his "surprise," "unsympathetic and inept." Regarding the "evolutionist authors" he is "most familiar with"—L.H. Morgan, L.A. White, M.D. Sahlins—he found my "scholarship shockingly bad." On this basis, he speculates as follows: "Since it seems unlikely that he [Harris] would concentrate his mistakes on these few, it must be that other authors were unread or misread as well."

Not a single substantive fact or interpretation is given to support Service's claims. There are in addition, deliberate misrepresentations of the reviewer's identity. L.H. Morgan, L.A. White and M.D. Sahlins are not simply, as he writes, the anthropologists with whose work he is most "familiar." Service is a professionally acknowledged partisan of these figures. L.A. White was Service's teacher and Departmental Chairman and colleague at the University of Michigan for over 15 years. White is Sahlins' colleague in the same department. White is the most prominent contemporary exponent of L.H. Morgan's evolutionary thought. Finally, Service and Sahlins are co-authors of a book on cultural evolution which was strongly influenced by White's views.

Service writes that my critique of his position was negative "much to my surprise." The fact, however, is that Service was one of the readers who was asked by a potential publisher to evaluate *The Rise of Anthropological Theory* when it was in manuscript. There is nothing in the book which can possil be surprising to Service. Not only c he read the manuscript over a year a but he strongly recommended it publication!

I have before me the copy of a fo page, single-spaced letter which Serv wrote to me on that occasion and fr which I shall quote in a moment. T principal substance of that letter c cerned Service's objections to my tre ment of Sahlins, Service, White a Morgan. He especially disagreed w my evaluation of Sahlins' and Servic "specific and general evolutio White's emphasis upon neo-evoluti ism, rather than cultural materialis and Morgan's role as a Spencerian ductionist. What Service is now s prised about is my refusal to make t changes he recommended.

I believe that readers of NATUR HISTORY magazine may be interested Service's opinion of my book before found out that he could not get me change my view of the "evolution authors" about whom he feels so g erously protective (namely Service)

"I have just at this moment finish a reading of your excellent (and hug manuscript. Let me state at the v outset that I am enthusiastic about and full of admiration for the gr amount of work, reading and reflecti as well as the labor of composition t you have brought to it. The few cr cisms detailed below are supposed help, but I am amazed how few t are in a work of this size."

It is clear that having failed to c vince me of the correctness of opinions, and fearing that my o views will prevail, Service has ab doned professional standards of sch arly conduct, in the hope that he c somehow get enough people not to ma up their own minds for themselves.

MARVIN HAR
Columbia Univer

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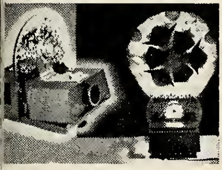

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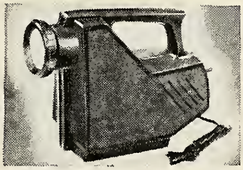

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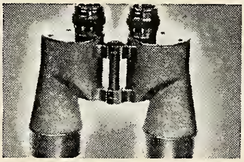

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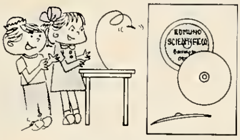
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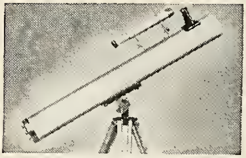

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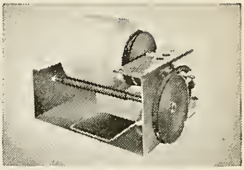

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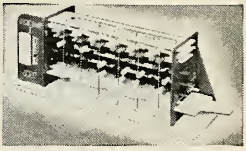

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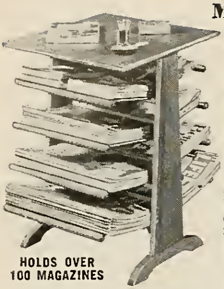

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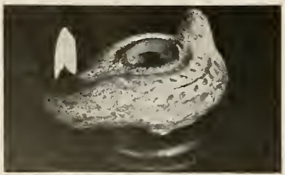

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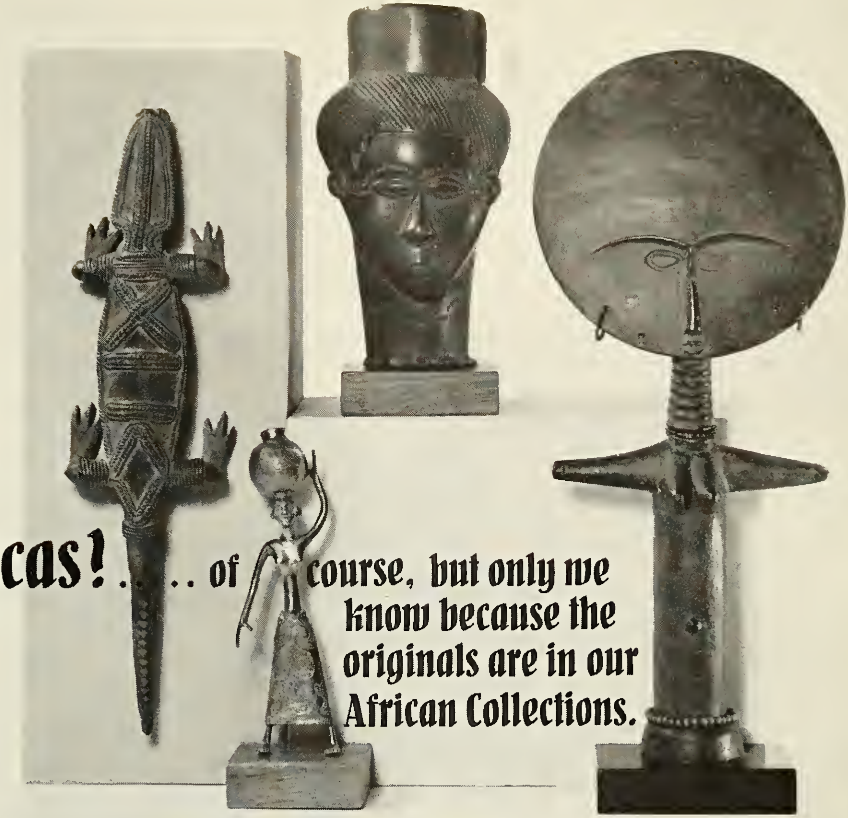
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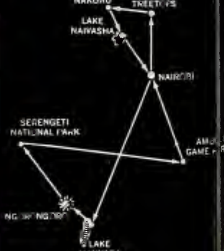

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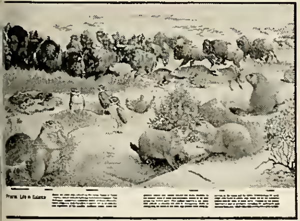

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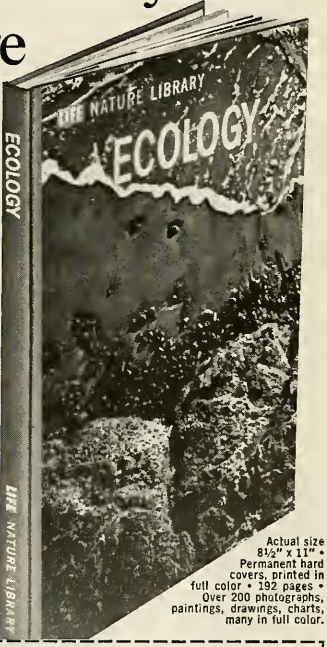

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THE AUTHORS

While working as a research field assistant on a study of Hutterite mental health, William F. Pratt lived in a Hutterite colony as the "English" teacher and visited many others in Montana and Alberta. Dr. Pratt, a Public Health Fellowship recipient, spent two years on a Ford Foundation-supported project at the Population Institute of the University of the Philippines. He is now Associate Professor of Sociology and Assistant Director of the Bureau of Social Research at The Catholic University of America, and is the author of several papers on demography.

Claudia Andujar's photographs have appeared in *Life*, *Look*, and at New York's Museum of Modern Art. Her pictures of Brazil will be shown at the Ford Foundation this year; and her book, based on a photographic study of a boy in Sao Paulo, will be published by Crowell-Collier. "In the Shadow of the Mountain", came from a recent trip to Peru.

Paul S. Martin's specialty has been the study of the Pleistocene, and among his major interests are pollen analysis, biogeography, and extinction of that period. He is Professor of Geochronology at the University of Arizona and has done field work in the southwestern United States, Mexico, Africa, and Madagascar. Dr. Martin, is president-elect of the Arizona Academy of Science. His article, "Wanted: A Suitable Herbivore . . . ," is his second for Natural History.

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Stephen F. Arno is working his doctorate in subalpine forest ec ogy at the University of Monta where he is a graduate assistant the School of Forestry. Mr. Arno came interested in American glaci during his back-country travels the mountain ranges of the West, while working as a naturalist Olympic and Sequoia-Kings Can National Parks. He has written articles on natural history interpr tion and conservation for *Natio Parks Magazine.*

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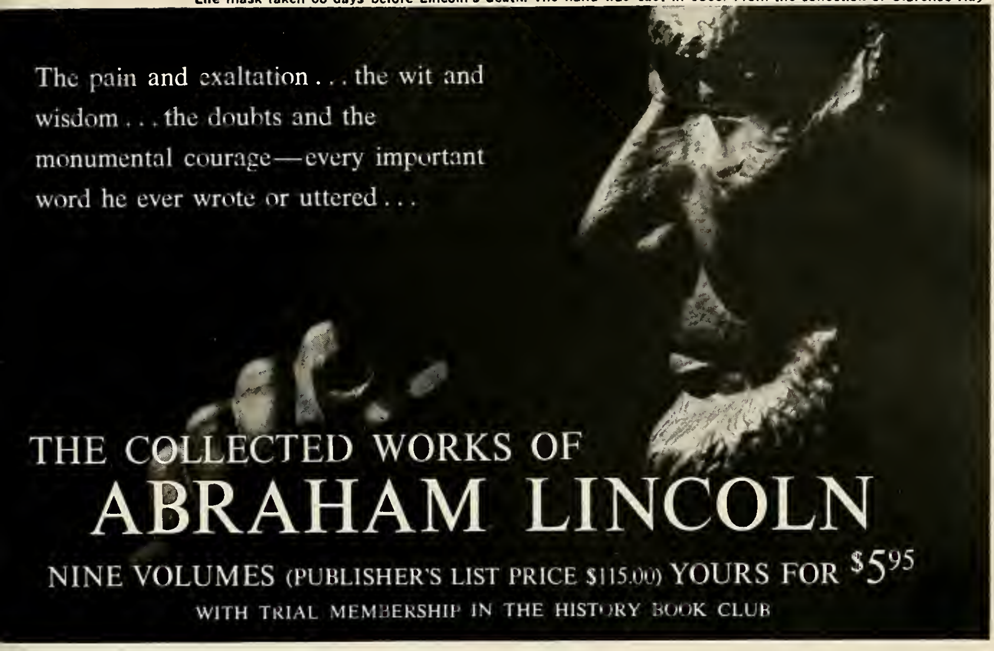
Life mask taken 60 days before Lincoln's death. The hand was cast in 1860. From the collection of Clarence Hay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In and Out of the Field

Alfred Meyer

After checking in at the hotel in Seattle early one morning, we register at the convention desk. The queue for such a simple operation is not merely long. It is tremendous. A shifting, unmusical snake dance, covering both sides of the mezzanine, and every now and then letting its tail slip into the corridor leading to the rent-a-car agencies. We pass the time chatting with a graduate student from the University of Alabama. She likes Eskimos. When our turn arrives, we receive, in exchange for our signature and something on the order of $10, two vital devices: a program of this 67th Annual Meeting of the American Anthropological Association (November, 1968) and a tag listing name and affiliation. We pin the tag to our lapel and then glide down the stairs to mingle in the crowded, churning lobby.

Here there is one task and one pleasure. The task is to sit down somewhere, study the program, and decide which papers to hear. The sessions of the first morning:

1. The Anthropology of Complex Societies
2. Attitudes and Values
3. The Anthropology of Modernization: Adaptations to Economic Change
4. Anthropology and Film
5. Political Anthropology: American Indians
6. Social Structure
7. Archaeological Problems, Methods, and Interpretations
8. The Evolution of Behavioral Pathologies in Cross-Cultural Perspective: Afro-American Data
9. The Vanishing Savage
10. Language, Linguistic Behavior, and Communication Systems

Considering that in each session an average of six 20-minute papers are read, the problems of choice and conflict are boggling, particularly if one is not an anthropologist, let alone a specialized one. The problems are also somewhat compounded by the improbable logistics of having to streak from Grand Ballroom B (9:20—Effects of Food Deprivation among the Logoli, Gusii, and Kipsigis) to the Colonial Room (9:40—Structural Analysis in Archaeology) and then over to the Spanish Ballroom (10:00—Work, Money, and Cargo: Early Stages of Modernization in Mt. Hagen, New Guinea).

The pleasure of the lobby is purely visual: watching anthropologists, the least homogeneous, least monolithic academic group in America. They are sporty. They are elegant. They brim with the baubles of a hundred different cultures. Earrings of Andean silver, decorated belts from the American Southwest, African shifts. A freckled, red-haired, young graduate student carries her infant daughter in a sling that must be Melanesian. An assistant professor from a university somewhere in California wears a charm from the south of India for a tie pin. His beard, however, is pure Americana—trimmed in the fashion of eighteenth-century New England whaling captains.

They are not all outwardly flamboyant, to be sure. Plenty of anthropologists here are unbearded and wear straight, middle-class American academic establishment garb. But it does not take much conversation to discover what inner marks of breadth and diversity other cultures have made on them.

The second day is more frantic. Schedules go awry, there is a plethora of disappointing papers read, and a luncheon appointment fails to materialize. Also, a certain lassitude hangs in the air. Missing is the sense of urgency that prevailed at the annual meetings a year before in Washington when the war in Viet Nam preoccupied almost everyone. If issues burned in Seattle, they burned quietly in their own alcoves among small groups of people.

But, finally, there is the Georgian Room, given over for the most part to the discussion and screening of anthropological films. At first, the Georgian Room served as a haven. The tired and the bored slipped in to watch the movies and to relax in the dark for a while. But the fare stimulated too much to afford anybody any rest. Even dated footage of the Australian Aborigines left one slightly breathless.

Notable among the new films are those done under the auspices of the anthropological film center at U.C.L. The one called "Mama," for exampl The subject is the typical day of young, unemployed black in a Ca fornia ghetto. The camera spares littl It even enters the sanctity of his sheveled bathroom to show him "ma ing up"—shaving, applying lotion pomading his hair. Then it follows hi as he sallies forth to the street, a you man on the make.

This film is in that region betwe the candid camera and cinema veri and unlike a typical documentary. power—and, presumably, its ethn graphic potential—lies in its treatme of actual, and even of extremely p vate behavior, rather than of idealize staged behavior. Many anthropo gists, however, will argue about t scientific validity of such films. Th contend, for example, that even t film maker's use of a close-up is convention of Western culture, whi regards the face or the head as t seat of the soul.

Anthropologists and other soc scientists will in the next few yea wrangle a great deal over the tec niques and uses of the ethnograph film. In Seattle, the discussion see to have started in earnest—in comm tees, in open sessions, and over glas of beer. It generated that ferment often associated with concepts that still novel and loaded with promi It also, finally and mercifully, re vigorated the annual meetings.

On the day of Twelfth Night—Ja ary 6, 1969—*The New York Tin* published its National Economic view. Much of it was ruddy w optimism, some of it was testy a cautious, and some was just pl bleak. The sternest pronouncements environmental trauma came from R Dubos, of Rockefeller University. Th rang amid his warnings one wistful, forgettable sentence: "For example, no longer notice that the air over url agglomerations is hardly ever lu nous and fragrant." When did you experience luminous and fragrant a? Can you even remember what it s like and how glad you were to be ali?

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The Anabaptist Explosion

The family-oriented Amish have a birthrate twice that of the United States average, while the communal Hutterites are the fastest growing ethnic group on earth

by William F. Pratt[*]

The survival of the Hutterites and the Amish, two religious sects whose communities are found in various parts of the United States and Canada, is a cultural anachronism. That these Anabaptist societies have persevered over several hundred years fraught with persecution and rejection is surprising enough. That they have maintained their medieval faith and their unsophisticated styles of life in a rapidly changing urban-industrial environment, is an ecological phenomenon of considerable moment. But of particular interest is their traditionally high level of fertility, which has persisted while their mortality rates have approximated that of the surrounding society. Consequently they have experienced a phenomenal growth from natural increase, which has created portentous problems for them.

The Hutterites, settled in South Dakota, Montana, and the prairie provinces of Canada, and the Amish, formerly centered in Pennsylvania and Ohio, have birthrates of 46 and 33 per 1,000 population, respectively. A century and a half ago, the United States birthrate was a lofty 55—over three times higher than its present level: in 1967 it had dropped to an all-time low of 17.9 births per 1,000 population. It is against this shifting background that the continuing high fertility of the Hutterites and Amish is so startling.

Comparable fertility rates show that from age 20 Hutterite women have much higher birthrates than those of American women in general. Even in their late childbearing years (40 to 44) their birthrate exceeds that of American women in their peak childbearing years (20 to 24). (The Amish women, in a somewhat freer society, have birthrates about midway between those of Hutterites and of American women in general.) It may be that two centuries of high fertility, combined with the inbreeding brought about by the social isolation of the Hutterites, has created a unique strain of the human species—a strain distinct in its fertility from any other people. Indeed, the Hutterites, with an annual natural increase of about 4 per cent, are possibly the fastest growing population on earth. Between 1950 and 1965, their numbers almost doubled, from 8,500 to 15,000. The United States growth rate, by contrast, is only .79. This would double the population in about 90 years, compared with a doubling among Hutterites about every 17 years.

The fertility of the two Anabaptist sects is one reflection of their rigidly theocratic cultures, which have managed to survive in an urban-industrial nation of 200 million that is wholly alien in outlook to the sects' own beliefs. At the same time, their rigid separatism, their being conscientious objectors, and their rapid growth have made these sects a focal point of hostility among their neighbors. The problems of tl
Amish families with respect to pu
lic education are familiar. As f
Hutterite colonies, land laws ha
been proposed several times, and
some cases passed, to restrict the
spread. At their present growth rat
Hutterites would number 64,500 l
the year 2000, and more than 55 m
lion by 2168. Today, their coloni
occupy about 1,000 square miles; l
the year 2000, they would occupy

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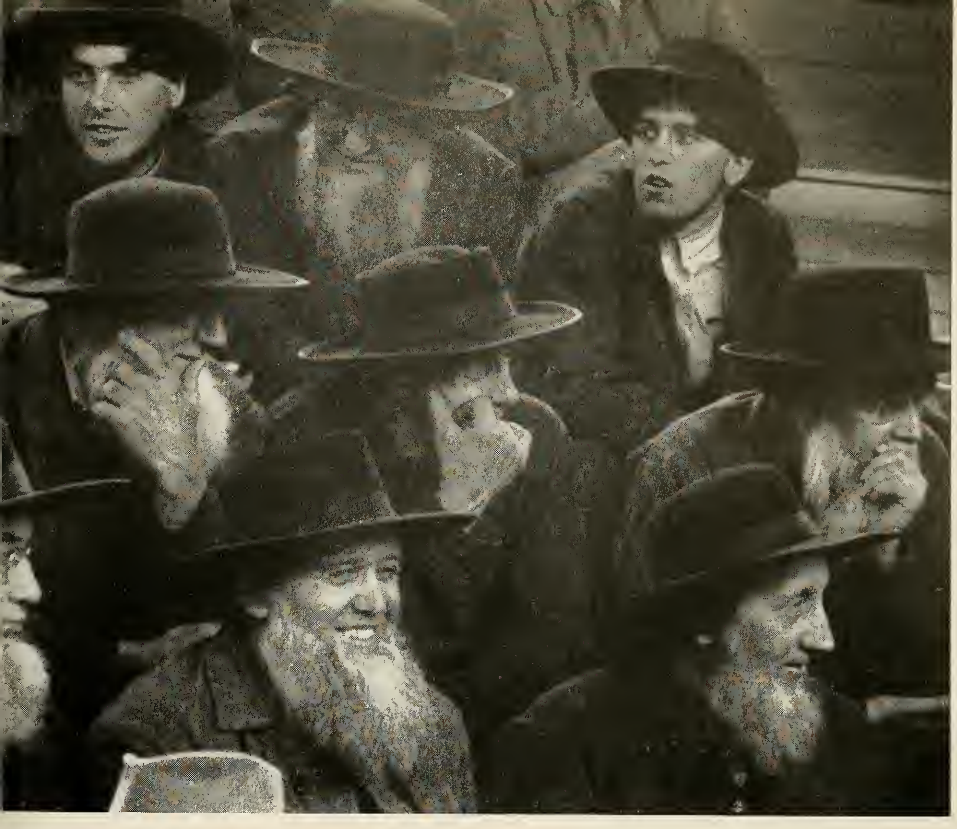
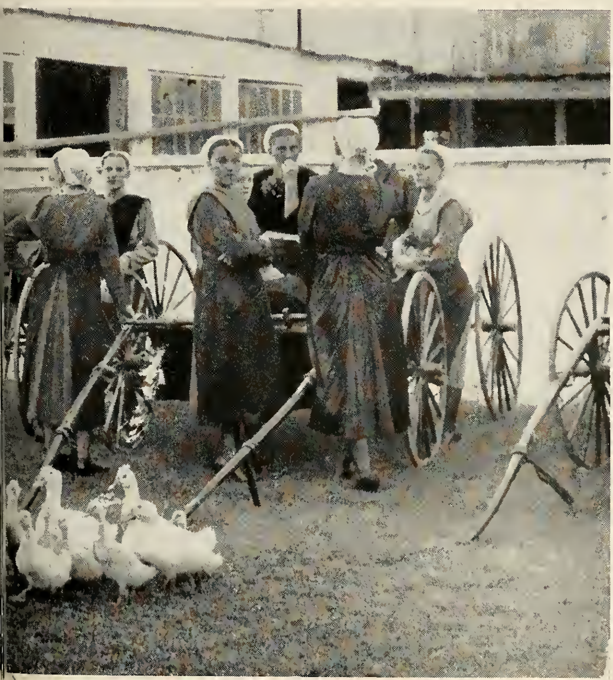
[*] Adapted from "Pockets of High Fertility in the United States," *Population Bulletin*, November, 1968, Population Reference Bureau, Inc. (Robert C. Cook, Editor).





Young Amish join their elders at a Pennsylvania country auction while the young ladies gather around the buggies that brought them. Each sex is wearing its typical costume, which is topped by hat or bonnet. In this pacifist sect the fully mature men wear beards but shun mustaches, which are held to be martial. More individualistic than Hutterites, the Old Order Amish are also seeing more of their young men "emigrate" to the even freer secular society around them.

area almost equaling Connecticut.

The difference in birthrates of the two sects is intriguing. It undoubtedly reflects differences in social organization and comparative success in adapting to the secular milieu of modern America. Despite their common origins and life style, they differ significantly in important respects.

Hutterites: A Dissident Sect

The Anabaptists of the Reformation comprised several quite different sects, from the radical and violent Munsterites to the equally radical but wholly non-violent Hutterites. What they shared was the label "Anabaptist"; it referred to their central belief in adult "rebaptism," baptism upon confession of faith. All these Protestant sects were religious responses of the socially disinherited of the Holy Roman Empire in the late fifteenth and sixteenth centuries.

Peasants, journeymen, and the landless were the most abject victims of that period's crises. Many turned from a cheerless reality to the comforts of a religion that made a virtue of their poverty and built a brotherhood on their passive suffering. But then, Martin Luther and Huldrich Zwingli alike, having gained their patrimony from the state, turned upon the rabble. In 1527, the Swiss Anabaptists responded by formalizing many of the tenets that still characterize Hutterites and Amish. Among these are adult baptism, separation of church and state by the withdrawal of believers, and an emphatic rejection of violence. From the outset, then, Anabaptism was regarded as a threat to the established religious and secular authorities, both old and new.

Unsafe in Zurich, the Swiss Brethren—the main body of Swiss Anabaptists—found refuge in Nikolsburg, Moravia, where their mounting numbers undoubtedly created severe economic strains. These were soon reflected in doctrinal disputes between a liberal majority and a strict, radical minority. The radicals, proclaiming Christian communism, worshiping separately, holding fast to adult baptism, and rejecting military violence even to defend themselves, were expelled in 1528. At that time they symbolically spread a cloak upon the ground to receive their worldly goods. This formally inaugurated the practice of "community of goods," which made them unique among sects descending from the Swiss Brethren. Under the organizational genius of Jacob Hutter (martyred in 1536) this radical group became known as Hutterites.

Although their communities flourished and increased through the first 100 years, they stood constantly in the shadow of persecution and dispersal. Between 1529 and 1622, an estimated 85 communal households, averaging from 300 to 400 members, had been established. But, by 1625 the sect had almost completely migrated to Hungary. There, the re-establishment of Catholic authority and the rise of the Jesuits overcame the reluctance of the nobility to persecute the Hutterites. Invasion by the Turks added to their troubles. Also considerable internal discord arose and by the end of the seventeenth century, membership had been greatly reduced by apostasy to Catholicism.

Of the faithful. most migrated to Slovakia, Transylvania, and Walachia, and later to Russia. Here, unable to re-establish communal life they accepted the individual famil culture practiced by the Mennonites an independent Anabaptist movement that also had set up some communities in Russia. In the 1870's fearing Czarist persecution, mos Hutterites migrated to the Unite States where, returning to their former, communal order, they established three colonies, comprisin about 440 persons.

Hutterites of North America

Thus began a demographic epi As of January, 1965, there were 16 organized communities, averagin 94 "souls," in the U.S. and Canad This growth to over 15,000 peop is about a 33-fold increase, or ov five doublings of population in le than a century.

These figures are the more remarkable because the Hutterites ha been a "closed population" since a rival in America. Their growth h come entirely from natural increas the excess of births over deaths.

Even when adjusted for diffe ences in age distribution, the Hutte ite death rate is only 85 per ce of the United States figure. The Hı terite rate for infant mortality in t past was above the national figu

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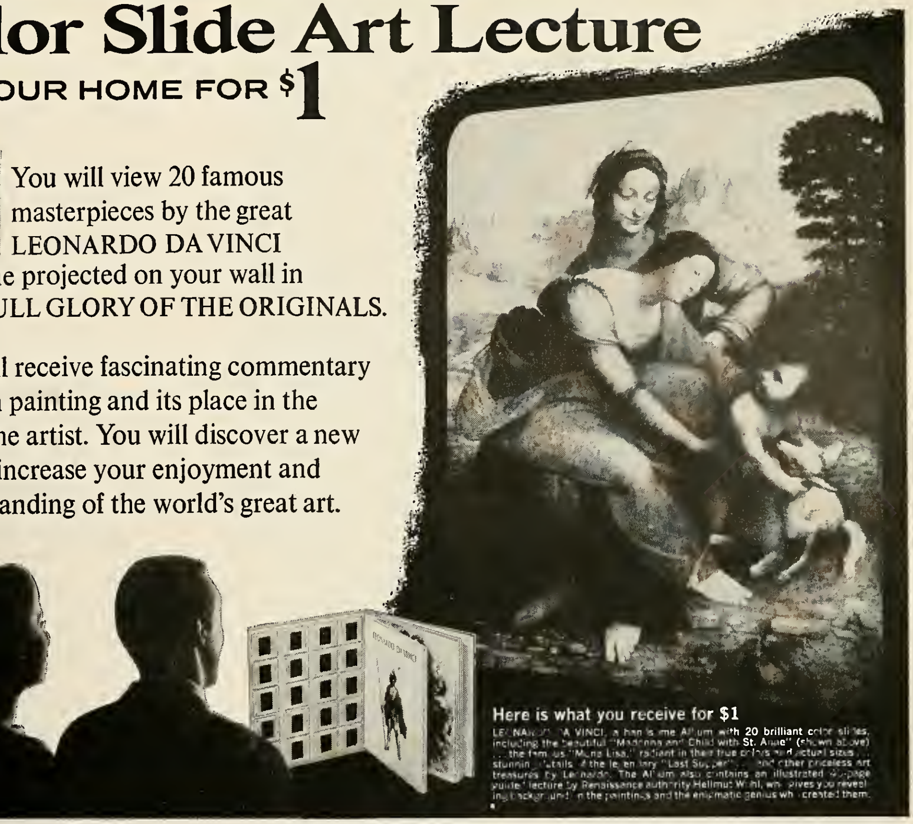

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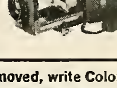

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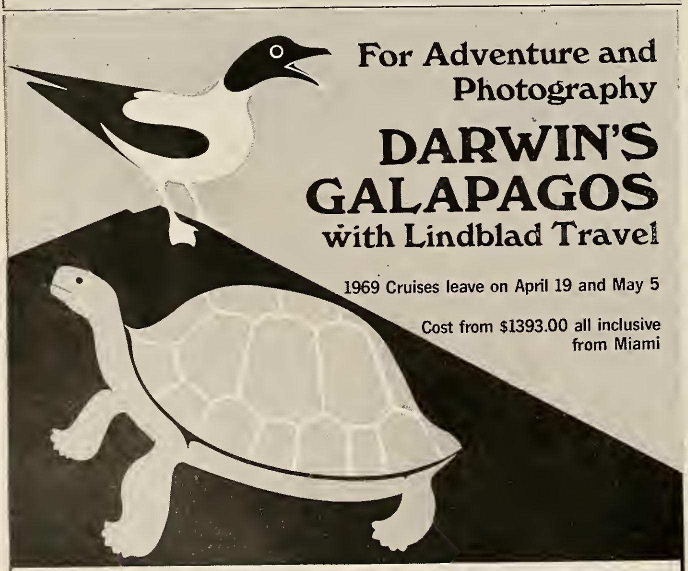

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but with improving medical care and health practices this too may now be equal to or less than for the nation as a whole.

Some practices, such as considerable reliance upon midwives, remain old-fashioned, but in general the Hutterites have adopted modern medical facilities. Although thei anti-intellectualism and separatior from the world have deprived then of the outstanding medical personne they had in an earlier era, Hutterite do not hesitate to send ailing mem bers to the Mayo Clinic and othe medical centers. A recent study sug gests that they may be spendin more per capita on drugs and medi cal care than do most Americans. I their favorable mortality has bee purchased at the cost of greater de pendence upon the outside, it i nonetheless consistent with their his torical emphasis on health and med cal practice.

The exceptionally high fertility c Hutterite women is most sharply see in their average completed fertilit It totals 10.4 live births, owin partly to the remarkably high rat of childbearing in the later ferti years. According to sociologists W. Eaton and A. J. Mayer, the fe tility rate of over 425 per 1,000 f Hutterite women aged 35–39 e ceeds that for women in any oth culture now on record. Even at ag 40–44, Hutterites have a fertili rate higher than women in Franc Sweden and the United States du ing their years of maximum fertilit ages 20–29.

So striking a deviation sugges that something more than social theocratic mores are involved. T inbreeding within the Hutterite pc ulation must be considerable. Sin the 440 original brethren with or 15 patronyms among them (70 p cent had only five patronyms) ca to America a century ago, they ha attracted no "new blood." In vi of the higher mortality of Hutter women in the childbearing years a the continued reproduction of th women rugged enough to stay course, genetic components fav ing a superfecund strain in the s cies must have been added to e Hutterite gene pool. The degree o which inbreeding may have ma this population genetically more u form (homozygous) would depe on birth and marriage patterns wi the colonies. Until a detailed ıetic analysis of the Hutterite ligree becomes available, it is im- ssible to derive accurate inbreed- ; coefficients and thereby add atly to our knowledge of what in- eding does to human populations. \t any rate, Hutterite fertility has restrictions and strong positive ouragement from the culture. tterites take literally the Biblical unction to "be fruitful and multi- ": sex as pleasure is devalued and ıfined to marriage, the chief end which is to beget children. Birth ıtrol, including the rhythm meth- is prohibited. All but a very few tterites marry, divorce is un- ıwn, and remarriage after the th of a spouse is frequent. The y major restraint upon fertility is relatively late age at marriage, ıbined with prohibition of pre- ital sexual intercourse. Sociolo- John A. Hostetler reports that 965 the average age at marriage 23.5 for men and 22.0 for wom- compared with the national rages of 22.8 and 20.6 for men women, respectively.

'hese direct factors are supported the general cultural patterns of ımunity life. Lack of privacy in 's household and possessions ld make difficult the use of most hanical or chemical contracep- methods; and failure to bear dren within a reasonably short after marriage or the last birth s gossip and insinuations about s health and the health of one's riage. The same lack of privacy es premarital sexual adventures kely, not to mention the severe t and ostracism that a premarital nancy would bring.

ı any case, there is little, if any, ivation for birth control. Unlike iders, the Hutterite family does face the economic uncertainties attend death and unemploy- t; it does not have the responsi- ies of maintaining its own rate household and facilities; e all, it escapes "keeping up the Joneses." The simplicity of erite consumer needs, the econ- s of communal life, the low ed- ional costs, and the early age at h youth enter the colony's pro- ive enterprise all keep the costs ıildbearing very low compared he general population. This d seem to leave the state of the

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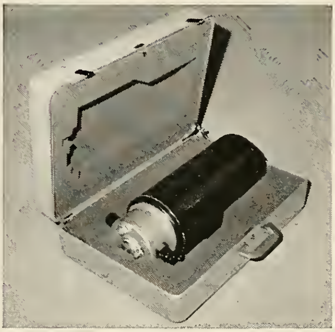

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woman's health and the strains of childbearing as the only plausible focus for trying to limit the number of children, and so far, these considerations have had no observable impact on fertility.

In view of its remarkably high fertility and rapid natural increase, the intriguing question is: how has this anti-intellectual, medieval communal order managed to adapt itself to a highly secular, urban-industrial environment and its rapidly changing technology? Other Anabaptist groups have clearly not resisted surrounding secular influences so well.

No longer subject to the whimsies of noble patrons, as in Europe, each Hutterite colony is an independent corporate enterprise integrated with the larger American economy. Hutterite economy is more specialized in agriculture today than when they were in Europe; they have sacrificed many of their former crafts and trades for modern mechanical skills and the economies of wholesale purchasing.

But their assimilation is exclusively at the economic and corporate level. Life within the contemporary colony is a revitalized communal order. Esthetic and individualizing interests are suppressed, as of old, by a common style in all things—a style marked by simplicity and sturdiness of materials. Thus active economic choice does not intrude, and invidious status differences do not arise. Financial matters and control of funds are strictly communal. Although not motivated by profit, Hutterites are shrewd businessmen who must maintain a substantial level of savings for contingencies and for building new colonies every generation or less.

So far as possible labor remains communal, and responsibilities are divided according to age, sex, and "election" as in former times. Cooking is done in a communal kitchen; eating is in a common dining hall. Although each family has one to two rooms in a communal apartment, toilet facilities are shared.

By isolating themselves socially, Hutterites sustain a strong sense of solidarity and a remarkable integrity of their communal life. Their rural location; the restrictions on working for outsiders; their language and quaint clothing: all help to separate them from the world. Information about the outside is primarily through the daily newspaper and farm journals, plus infrequent trips to town; but radios, TV, and movies are forbidden. Although bilingua and maintaining their level of literacy, they refuse state education beyond the legal required age, and maintain a parochial school in the colony to keep the children at home The "English" teacher, certified by the state or province, generally lives in the colony, but is as physically and socially isolated as Hutterite courtesy and hospitality will allow.

This social isolation of the Hutterite group itself is reinforced by a psychological turning inward. By constant reflection on their historica persecution and references to it, Hutterites maintain a fearful view o the outside world. The conditioning begins in earliest childhood, whe Santa Claus is described as a bogeyman who kidnaps naughty children consequently the youngster shrink from strangers. Also, the fundamentalist religious message stresse God's wrath and vengeance upo those who enter the world, or behav in worldly ways (against the community rules), and his forgiving lov for those who repent. These teachings begin in the communal kindergarten and continue in the "German" school to age 15, where the are reinforced by the strict teache In sum, a somewhat paranoid fea of, and prejudice toward, the large society is ritually induced fro childhood, while the ascetic disc pline of the community life com to be viewed as the comforting, fo giving, God-given haven.

Contemporary Hutterites a keenly aware that colony size is als basically important. By limitin colonies to a maximum of about 15 members, they can preserve close i terpersonal relations, with privac nearly impossible and competi cliques seldom arising. When t colony population becomes too larg however, stresses do occur and fe ings polarize along family and ki ship lines.

This internal source of disrupti is normally muted in several wa that characterize Hutterite co munal life: the economic indepe dence of the family is eliminate family-centered activities are mi mized; men and women are se rated in labor, dining, and worshi

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household privacy is limited. orth American society also fos- ; their internal solidarity. From e to time their colonies have n harassed by neighbors and by mpted legislative restrictions: se plus the jibes and prejudice of siders suffice to keep their fears y much alive, even though their its have been strongly protected. ost significant perhaps is that outside no longer offers a viable ng alternative for the individual tterite or family. Neither by edu- on, social skills, nor psychology ne Hutterite prepared to compete he larger society. Since 1918, no e than 2 per cent of all Hutterites e ever forsaken their colonies. young man who does "try the world" almost invariably feels a n sense of loneliness and returns hort order, expressing a sense of t toward his parents.

sses and Strains

o the casual observer, Hutterite ety may present the illusion of hangeability over 400 years of ory. A paradox is closer to the h: they have changed, and in lamental ways, in order to re- n the same. A simple example is principle of adult baptism. Al- igh it is still observed in form, plays a crucial part in Hutterite alization, it has long since lost its inal meaning. Today's young terite adult does not "choose" community life after having ex- enced and rejected the "world" ts own terms. He has been very essfully conditioned to fear the ide, to feel inadequate in the of it, to cherish the psycholog- shelter of the community.

ill the adaptive processes that so far preserved the Hutterite ire continue to operate in the finite future? This will depend ow much the stresses and strains intensified by the phenomenal lation growth.

ie communal operation has an or optimal labor demand that ies a population of about 100 ons in all ages. As sociologist r Peters observes: "A new col- with a population of about 100 ons will have an adult labor . . . of about 30 men and wom- Approximately 15 . . . will be , which means that almost all em will be in charge of an office

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or enterprise. . . . As the population increases, there are duplications in the various enterprises (by a system of assistants)."

This is the stage at which invidious distinctions among equals arise and cause tensions; the basis for cliques and divisions along family lines now begins to emerge. The resulting tensions play upon the problem of esthetics and the adoption of consumer conveniences. In short, the intimate, primary relations of colony life begin to give way to more formal regulations and supervision. However, when colony size reaches about 150 members, the more informal, brotherly atmosphere of community life is re-established in Hutterite fashion. The oversize community splits, ameba-like, into two communities: one new and one old.

The rapid increase in colonies provides a classic illustration of ecological competition for territory, and of population's role in intersocietal conflict. Hutterite aloofness is a source of prejudice, their economic efficiency is a source of envy, their refusal to bear arms can raise hostility to the boiling point. More direct and basic, the colonies, like corporate farms elsewhere, have reduced the population base that formerly provided support for the economies of local towns. The Hutterite ability to purchase wholesale from more distant centers further depresses the economy of these nearby towns. In some instances, Hutterite refusal to participate in local programs, such as rural electrification, has denied these services to other local farmers.

Against the resulting hostility Hutterite protestations about contributing to the health of state and national economies, about paying school taxes from which they receive little benefit, about not drawing upon outside welfare funds to which they contribute, and about not contributing to problems of crime or mental illness are of little avail.

True, opposition so far has not blunted either their financial security in the general economy or their constitutional protections as citizens. Nonetheless, they have experienced outbreaks of vandalism against some of their colonies, especially in wartime, and there have been numerous proposals to restrict their land buying. A land law in Alberta requires that Hutterites purchase new colonies at least 40 miles away from any other and not exceeding 64,000 acres. To challenge such laws, Hutterites have been obliged to set up something hitherto alien to them—a national church. Though this secondary organization has had little effect on the daily operations of the colonies, it contains the seeds for wielding financial power and regulating communal life in a non-Hutterite way.

Given that this sect will number about 64,500 people in the year 2000, it is reasonable to expect that outside opposition will press harder for changes in Hutterite life. Moreover, given that Hutterites would number 55 million in another 168 years, it is clear that either their growth rate or their way of life, and probably both, must give way to change before that time. A fascinating experimental case study in the social consequences of demographic patterns appears to be rapidly unfolding before our eyes.

The Beleaguered Amish

Despite various similarities be-

Characteristics of two Anabaptist sects, clockwise from top: as at other Hutterite colonies, emphasis is upon efficient farming methods, of which raising top-grade livestock is an example; the two Hutterite mothers belong to what is possibly the fastest growing population on earth; gathered for the group photograph are a proud Amish father and his family; at school the neat lad will find other Amish wearing the same costume.

tween the two sects, the story of the Amish is far more of a contrast with that of the Hutterites, especially in modern times.

The Amish arose as a branch from the Mennonites, an independent Anabaptist movement centering in the Netherlands. The Mennonites envisaged small, homogeneous, and self-sufficient communities living a scriptural way of life. Unlike Hutterites, they advocated no theocratic communism or any other economic mode of community life. In practice, like the majority of Swiss Brethren, they embraced the doctrine of Christian stewardship of private property and made the family the basic economic unit of their society.

However, the fanatical Mennonite preacher, Jakob Ammann, preached a harsher system of discipline. In 1693, angered by the refusal of a group of ministers to confer on this issue, he censured the lot of them and founded his own sect, the Amish. Thus was Amish life rigorously formalized and made more repressive.

Also for comparison: the migrations of the Amish—unlike those of Hutterites—have always occurred within the sphere of advancing Western culture rather than its backwash.

From communities widely scattered over western Europe, the Amish emigrated to the United States over a long period of time, beginning with the first settlement, in Pennsylvania, in 1727. After the Napoleonic wars, large numbers of Amish fled Alsace and Bavaria, settling in Ontario, Illinois, and Ohio. Shortly, they were followed by others from central Germany, who settled in Ohio, Pennsylvania, and Maryland. By 1900, the Amish had either abandoned Europe or been reabsorbed by the Mennonites.

Through exceptional frugality, industry, and farming skill, the Amish prospered in their earlier years in America, compared with their neighbors. Today the economic situation is reversed. The modern non-Amish farmer, utilizing farm machinery forbidden to the Old Order Amishman, is far more productive and also much less burdened by a large family. (Reference to the "Old Order Amish" reflects the fact that over more recent times, the traditional order of Amish life has eroded and produced several schisms.)

By 1960, there were 258 loosely defined Amish "districts" in 19 states, with a total Amish population of about 43,000. Six years later the population had grown to 49,370, an increase of just under 15 per cent, compared with 9 per cent for the United States as a whole. The Amish increase would be even greater were it not for their steady loss of members who "emigrate" to the larger secular society.

In any case, the noticeably higher increase in the Amish population results almost exclusively from their higher fertility. Interestingly, the Amish apparently have a higher rate of twin births compared with the general population, suggesting the presence of a distinct genetic factor. Equally interesting is the lower fertility of the Amish compared with the Hutterites. Any superfecundity among the Hutterites might explain part of this difference. But, since the Amish have lower fertility than many other contemporary populations, a significant portion of the difference with the Hutterites must come from the spread of birth control methods among the Amish.

Their higher fertility compared with that of the United States reflects a continuing influence of their fundamentalist views, but their lower fertility compared with Hutterites reflects the erosion of their large-family ideal. Although Amish couples marry somewhat younger than Hutterites, they produce fewer children per family. The median number of children in an Amish family is 6.7; it is 10.4 among the Hutterites. Yet Amish doctrine, no less than that of the Hutterites, prohibits contraception and promotes the large-family ideal. Moreover, unlike Hutterites, they reject modern technology. This difference theoretically promotes the need for many farmhands, and these must come from the young. The Amish youth, like his Hutterite counterpart, enters the economic life of his community at about age 15.

In relations with the larger society, the Amish have probably been hurt less by population growth than the Hutterites. They have been less of a competitive threat to their neighbors because their farming methods are less efficient and they do business in the local community rather than through their own com-

munal organization, as Hutter
prefer to do. On the other hand,
simple mode of Amish life undo
edly restricts the growth of l
business, especially in farm equ
ment and through a wide range
consumer goods.

It is in relation to the internal
of their communities that populat
growth has undoubtedly been m
distressing for the Amish than
the Hutterites. The family basis
Amish economy means that as po
lation increases, the community n
spread geographically. This ma
it increasingly difficult for e
member to be equally well
quainted with all the others; co
quently, those who see each o
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Moreover, the young people
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home and seek new land when
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In addition high fertility incre
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Actually, a population inc
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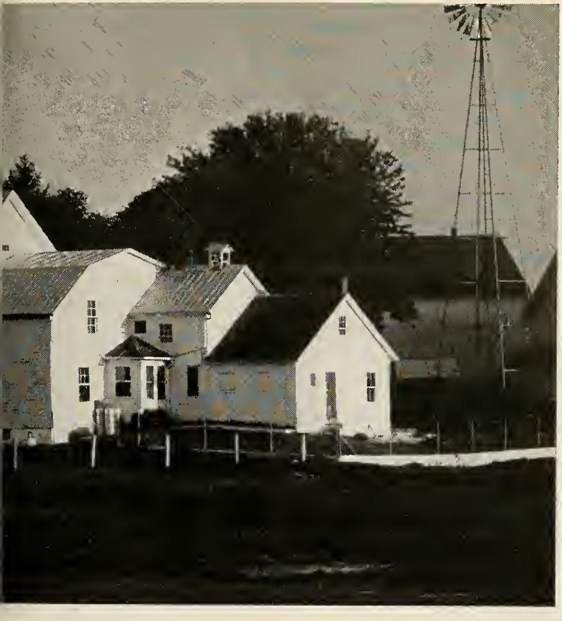
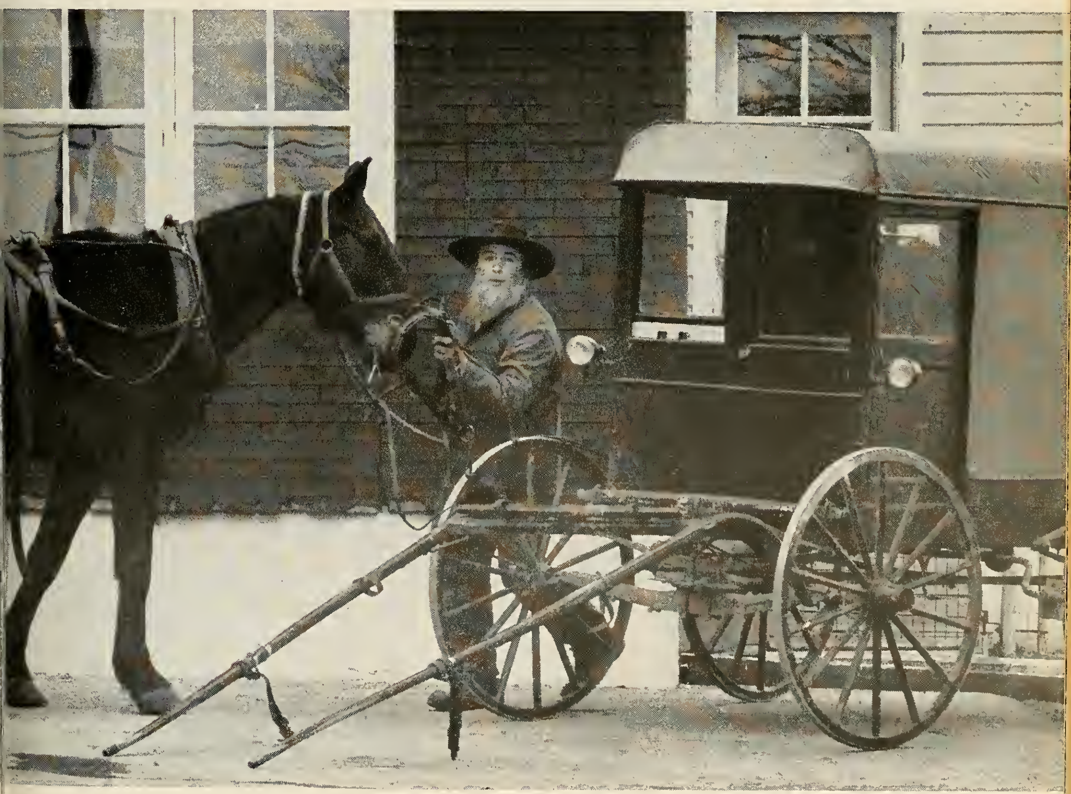
of change. The small size of
Amish economic unit—the fam



When generation follows generation upon an Amish farm the result can be the make-do kind of architecture at left. Children live with their active-farming parents in main part of the house. Center part was added on for grandparents, and rear part for great-grandparents. Below is another form of adaptation. Amish retain their horse-drawn method of transport but to comply with laws for night driving have added their own version of directional lights.



Known as serious, self-responsible farming folk, the Amish also have their relatively lighter moments. Above: the country auction gives them a chance to combine bargain hunting with time off for gossip. Top: after marriage, this courting couple will travel by closed gray farm wagon rather than open carriage. Right: the foursome of Amish women relax by watching a baseball game.

has severely restricted adaptability.

Unable to supply all its needs, either from its own resources or those of the Amish community, each family is compelled to operate directly in the larger market. Moreover, refusal to adopt fully modern farm technology restricts productivity and, therefore, family income. In turn, the income has to be spread among family members who include a higher proportion of non-productive dependents.

Equally significant, the family system involves transmission of property through inheritance. With large numbers of children (an average of three or four sons), the size of an inheritance naturally decreases, providing a smaller income base for the next generation. The average size of an Amish farm has declined from several hundred acres in the eighteenth century to less than 50 acres today.

In turn, smaller home farms compel many unemployed young Amish to seek labor on other farms or in industry. Recent studies in Middlefield, Ohio, reveal that only 47 per cent of the Amish labor force was engaged in full-time agriculture. Employment outside the community exposes the Amish youth to worldly standards and friendships, and to more lucrative modes of livelihood. Even the young person who returns to farming brings an intense awareness of the advantages of modern methods.

It is the formation of cliques, combined with this exposure to outside influences, that generates considerable pressures for change, not only in farming methods but in all other areas of Amish life. This explains why, today, there are several different degrees of departure from standards of the Old Order Amish. In short, adaptation for the Amish has meant a progressive loss of members who have discarded many of the old ways, though many still call themselves Amish.

Dogma in a Changing World

The story of the Hutterite and Amish offers a number of interesting things for contemporary man to think about. Two seem outstanding.

First, the impact of population on human affairs is dramatically demonstrated. Population movements do not enter human affairs only in the simplified Malthusian manner of too little food and too many people. Rather the impact of population on human affairs is pre-eminently determined by social organization. For both the Hutterites and Amish their very high levels of population increase have intensified competition with the larger society they prefer to avoid, and have heightened intergroup conflict. Also for both, population increase has violated the primacy of informal, intimate social contact of each with all. This is most clearly seen among today's Amish: many of their people have spread geographically beyond the possibility of regular, daily interaction among all family members.

A similar process operated upon the Hutterites before their American adventure. Today, of course, Hutterites dull the effect of population growth by regularly dividing colonies when cliques arise and tensions become marked. But their conflict with the outside has sprouted the roots of a truly formalized secondary association: they have had to form a national church, with all its undesirable potential for regulation and control. This dynamic effect of population growth on social change seems everywhere unavoidable.

And this leads naturally to the second observation. Man does not live by ideology alone. Despite the rigid and unreflective character of their doctrines, these two groups have experienced fundamental changes in their social organization. It is this unreflective certainty in the rightness of their doctrines—and the blinders they place on the next generation—that blinds both sects to the dynamic causes of their tribulations and their successes. The Hutterites, for instance, do not attribute the successful revival of their life in America to the economic efficiency of corporate farming, but to God's pleasure in their devotion. By the same token, they are unlikely to view their uncontrolled fertility as a principal factor in the probable unhappy course of future events. Perhaps they reflect a quite general human failing today: our conventional ways of thinking no longer provide rational solutions for contemporary problems of human ecology, such as that of population pressure so well illustrated by the Hutterites and Amish.

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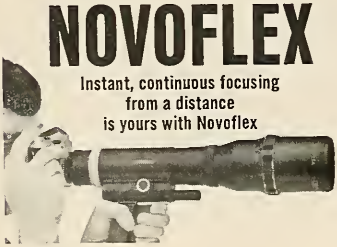

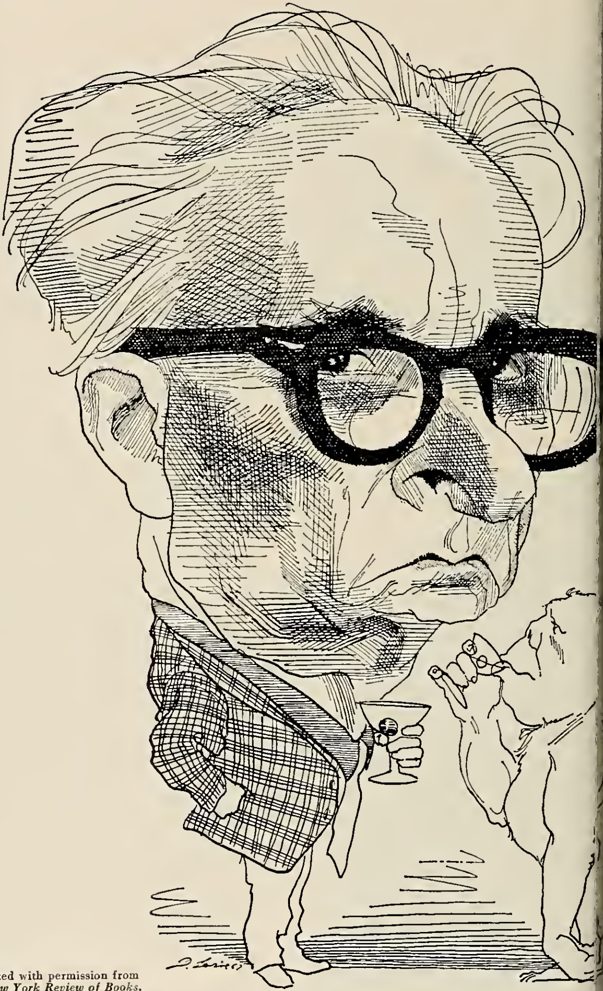

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Levi-Strau

finished Symphony: The Analysis of Myth

by Bob Scholte

THE RAW AND THE COOKED, by Claude Lévi-Strauss. *Harper & Row, $10.00; 384 pp., illus.*

In current French intellectual circles, structural methods and investigaions are definitely "à la mode." The ame of this "school's" most illustrious epresentative — Claude Lévi-Strauss—as virtually become an academic ousehold term. Innumerable Frenchen and quite a few others feel called pon to offer hommage to this "Pope of he Left Bank" or to chastise his disiples for their alleged "intellectual mperialism." But whether pro or con, ne important fact is abundantly clear: he philosophic influence and cultural ominance of structural anthropology ar exceed the restricted domain of thnological inquiry or the stately coridors of the "Laboratoire d'Anthroologie sociale." Not only in Paris but lsewhere, cinematographers and mucians, estheticians and literary critics, opular journalists and erudite comentators, professional philosophers nd intellectual historians, sociologists nd cultural anthropologists continue add their critical assessments and ried opinions to a growing body of condary literature on structuralism, s intellectual possibilities and theotical limitations. This popular acaim—whether French-continental or nglo-American, laudatory or critical, dicious or irresponsible—does attest the remarkable influence and intelctual importance of Lévi-Strauss' gintic achievements. Though at times barrassing to Lévi-Strauss himself, s many books are often best sellers d the constant subject of heated bates and learned interpretations. As e French critic was led to observe, hether we are Marxists or phenomelogists, Thomists or existentialists, are all of necessity structuralists.

The *raison d'être* for Lévi-Strauss' enomenal success is a complex one, ough one reason clearly stands out. is a French savant par excellence, nan of extraordinary sensitivity and human wisdom, an encompassing mind of considerable erudition and philosophical scope, a deliberate stylist with profound convictions and convincing arguments. These rare qualities are evident in all of Lévi-Strauss' writings, which explains why even his minute ethnographic analyses and specific ethnological arguments are avidly read and critically examined by interested laymen and knowledgeable scholars alike. *The Raw and the Cooked* (the first of four volumes devoted to the comparative study of myth) happily and ably carries on this scholarly and humanistic tradition. And the book adds yet another chapter to the tireless quest for a scientifically accurate, esthetically viable, and philosophically relevant cultural anthropology. The opening pages of the introductory "Overture" attest to the scientific continuity of purpose: to search for "an inventory of mental patterns, to reduce apparently arbitrary data to some kind of order, and to attain a level at which a kind of necessity becomes apparent, underlying the illusions of liberty." The study of mythology is an especially privileged domain for this deterministic understanding of "objectified thought and its mechanisms" since myths, unlike various marriage rules or lesser classificatory systems, "signify the mind that evolves them by making use of the world of which it is itself a part," that is, "an image of the world which is already inherent in the structure of the mind." Myth's quest for intelligibility is not, however, without its "objective correlate," its concrete realization in the domain of expressive imagery and sensed reality. In fact, myth is like music (the supreme mystery of the human sciences and the key to their progress): both are able to "act simultaneously on the mind and the senses, stimulating both ideas and emotions and blending them in a common flow, so that they cease to exist side by side, except insofar as they correspond to, and bear witness to, each other." Finally, this anthropological

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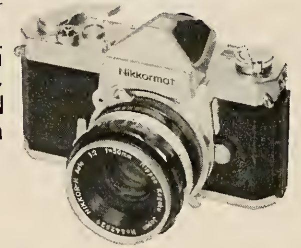

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delineation of a "science of the concrete" constitutes a philosophical testament to the intellectual cogency and existential viability of human thought—primitive or civilized. As Lévi-Strauss concludes in the as yet untranslated second volume of *Mythologiques*, mythic thought contains within itself the objective seeds of esthetic illumination and scientific intelligibility, not as an evolutionary stage in man's intellectual progress, but as a uniquely creative expression of one sociocultural variant of the diverse human condition.

The substance of mythology, like other modalities of man's intellectual activities, forms a response to what Lévi-Strauss—like Jean-Jacques Rousseau before him—considers a universal and fundamental anthropological problem: the transition from animality to humanity, instinct to intellect, literal to figurative, continuous to discrete, and from nature to culture. To render this monumental passage from the one to the other intelligibly, mythology carves out various domains of meaning and renders them explicable by mediating the given oppositions between them. For example, the mythic origins of the domestic fireside mediate between the "naturally" raw and the "culturally" cooked, the legendary waters mediate between the sky above and the earth below, religious funeral rites between the living and the dead, and so on. Lévi-Strauss traces the dramatic and complex contours of this integrative symphony of the mythic spheres by means of a detailed and exacting examination of the indigenous legends and primitive myths of American Indian culinary practices and cultural beliefs. The ethnographic data and ethnological analyses offered in these volumes simply defy a summary statement. In *The Raw and the Cooked* alone, 187 myths and their variants from over 80 tribes are discussed. In virtually every instance, a given myth is carefully described and intimately related to the totality of its sociocultural environment, its geographic, technoeconomic sociological, and cosmological contexts. The elements of the myths are further shown to pertain to the human senses (auditory, tactile, olfactory, and gustatory) and to other modes of intellectual classification (botanical, zoological, organic, esthetic, ideological and religious). It is the domain of the human senses (so inexcusably neglected by anthropologists), however that stand out as the mediators par excellence between the literally given and the symbolically meaningful. For example, the activity of cooking, the area of the cuisine, and the attendant gustatory code are significant because "not only does the cooking mark the transition from nature to culture, but through

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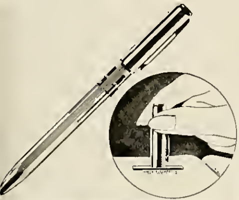

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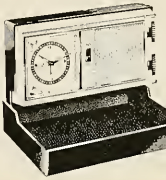

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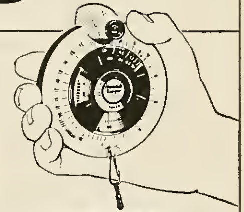

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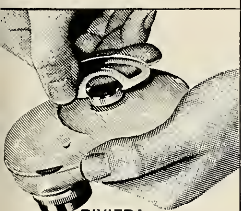

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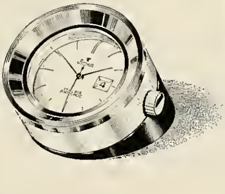

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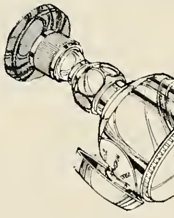

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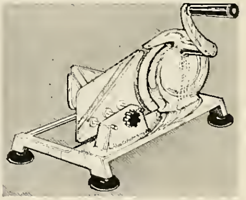

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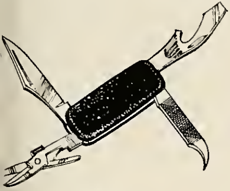

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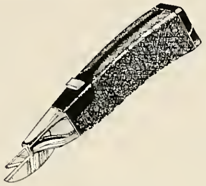

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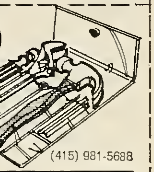

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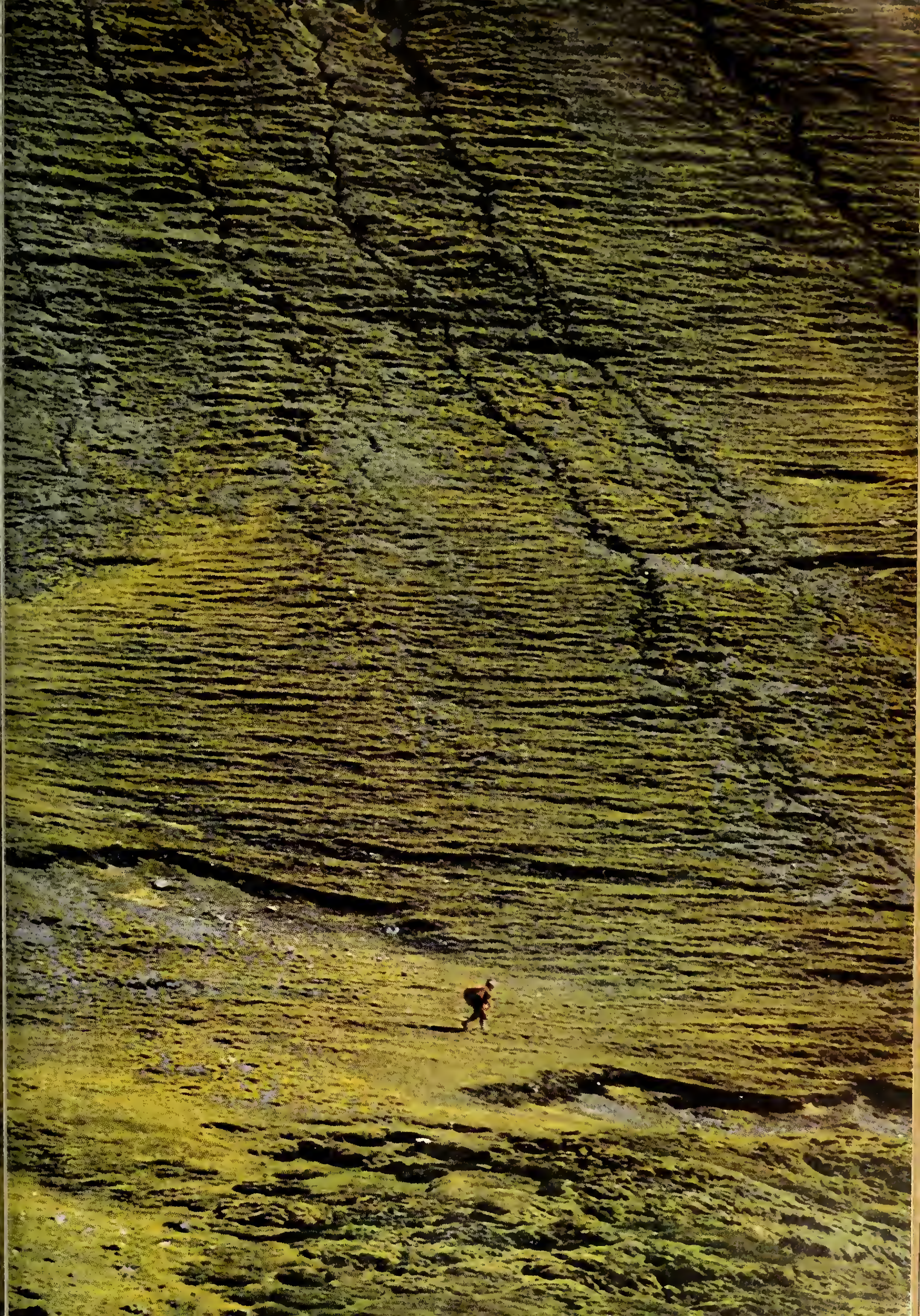
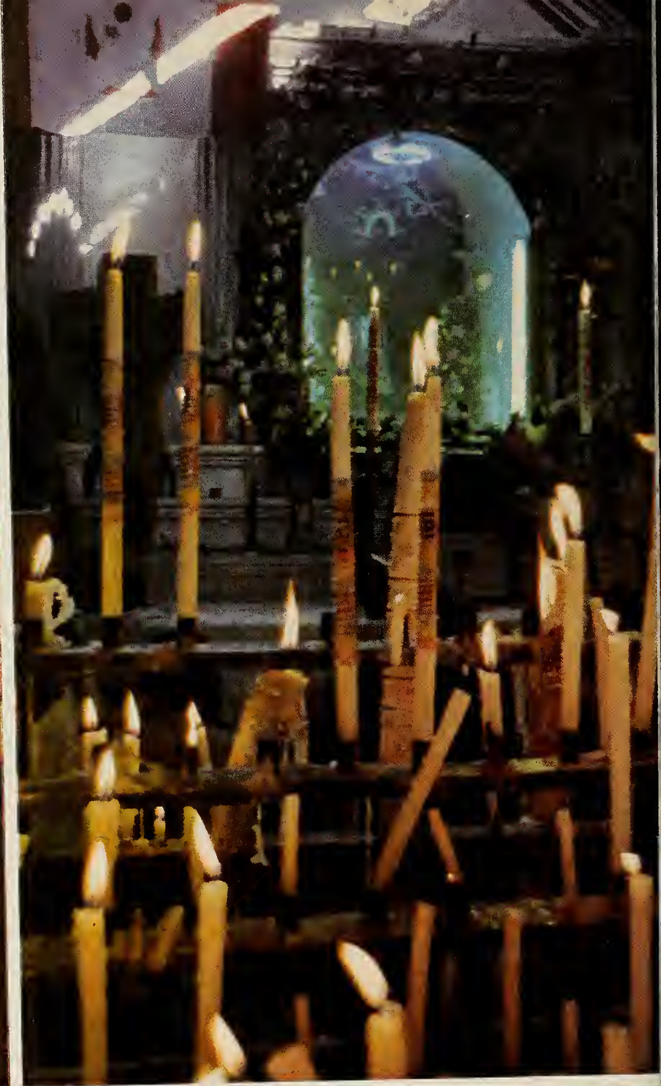
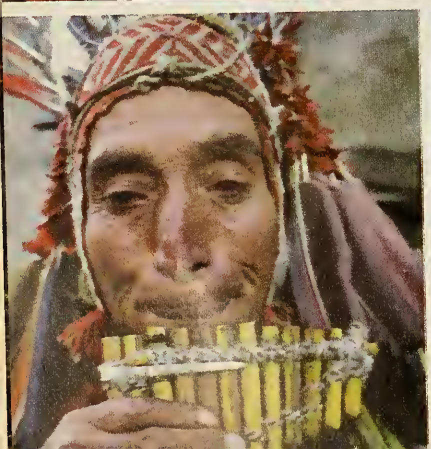
In the Shadow of the Mountain

photographs by Claudia Andujar

Once a year, during the South American winter, a part-pagan, part-Christian pilgrimage begins in the mountainous Cuzco region of Peru. About four thousand Quechua Indians ascend on foot to a small, uninhabited valley that is surrounded by the glacier of Ccolluriti (Quechuan for "snow star"). Here they camp for three days. Some scholars at the university in Cuzco believe that the pilgrimage is pre-Inca, dating back to a time when Indians of the Peruvian altiplano lived in small tribes and worshiped mountain spirits. Adapting this pagan tradition to its own ends, a Catholic order built a wooden chapel in Ccolluriti Valley to commemorate a miraculous appearance of Christ, dressed in the plumes of a jungle Indian, before a shepherd child of the mountains. The Indians now pay homage to Christ by undergoing hardship to reach and stay at Ccolluriti and by offering votive gifts. Many come to ask for miraculous help. The Quechua are stoic people, often withdrawn; but the deeply felt faith and the deprivation of the pilgrimage transform them. They become quasi-hysterical: they cry and lament, sing and dance.





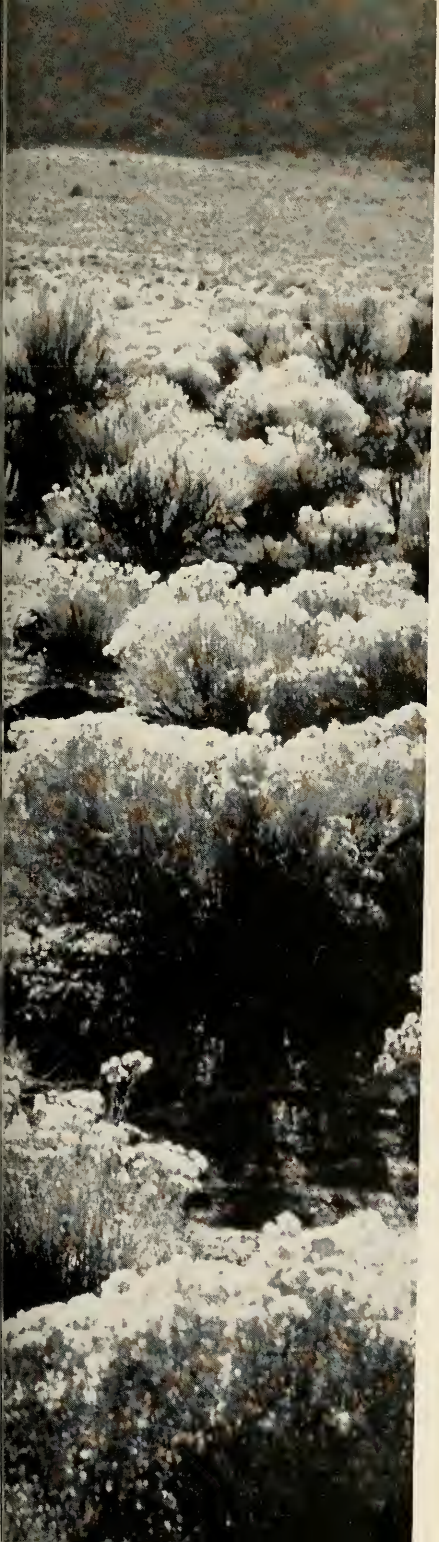


Three Days at the Church of the Snow Star

The climb to Ccolluriti takes a day. Moving slowly, with many stops, the throng proceeds to the song of panpipes. The Indians carry everything—firewood, food, large wooden crosses, votive offerings—in bundles on their backs. Some dress in the regional clothes of the surrounding mountain country. Others wear special costumes, ornamented with macaw feathers from tropical Peru, to celebrate the apparition of Christ adorned with the plumes of jungle birds.

The chapel is small, holding about a hundred people, and everyone wants to get in. Outside the chapel, dancing goes on day and night, if for no other reason than to keep warm. The nights are bitterly cold and there is no shelter. During the third night a select group of men—the *osos,* who disguise themselves as ferocious creatures and try to frighten women and children—climb up farther onto the glacier. They return bearing glacial ice blocks on their backs, thereby enhancing their reputation for great strength and bravery. These men evoke a formidable legendary *oso,* or "bear," who fell in love with and kidnapped an Indian girl by carrying her on his back into the mountains.

On the morning of the fourth day the pilgrims descend and Ccolluriti is left to its silence for another year.



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The ecologist's concept of a niche refers to the "job" or "trade" by which a species makes its living without excessive competition with others. An empty niche then implies neglected opportunities for utilizing available food energy. It is a common belief that nature abhors such vacuums and quickly fills them. Yet when seen in the provocative perspective of the last million years, there is evidence to indicate that some rather large niches within the American range remain unfilled. Perhaps the long-lauded home where the buffalo roam is also the land where camel and eland should play, as well as an array of other exotic large mammals usually regarded as more suitable for zoos than for meat production.

The matter is of more than theoretical interest. In confronting the calorie crisis associated with unbounded population growth, ecologists associated with the International Biological Program are seeking out sources of "new" energy. But this meticulous search has overlooked the forage potential of the shrub-dominated arid lands of the southwest United States and Mexico: a vast territory that is largely unexploited at present.

by Paul S. Martin

Cattle and Creosote Bush

Looking to the future, specialists in animal husbandry and range management generally attempt to increase range productivity with only one goal in mind: creating the best possible environment for the genus *Bos*. Water supplies are developed and pastures are rotated; native plants that are not consumed by *Bos* are destroyed if possible. When the range dries out in southern New Mexico, for instance, a herd may be trucked 500 miles to greener pastures in Colorado. Animal breeders work with geneticists in seeking to develop cattle more suited for life in arid or tropical areas. The only approach to raising productivity not being seriously tried at present is the introduction of new grazing species capable of utilizing certain types of plant life that cannot be consumed by domestic cattle. For all practical purposes, experiments with domestication of large wild herbivores ended in the Neolithic and have not been systematically attempted since.

In the New World, ranchers operating west of the Pecos or south of the Rio Grande seem to have inherited the wrong species to start with, for tradition demands that they stock a grass-preferring herbivore, *Bos*, in a land of little grass. Over approximately one million square miles of the southwest United States and Mexico, the dominant vegetation is composed of shrubs, often protected by thorns or by repellant aromatic oils. Cattle may browse seasonally on mesquite or even on cactus, but they are not well adapted for this role. Most shrubs such as creosote bush (*Larrea tridentata*) go untouched.

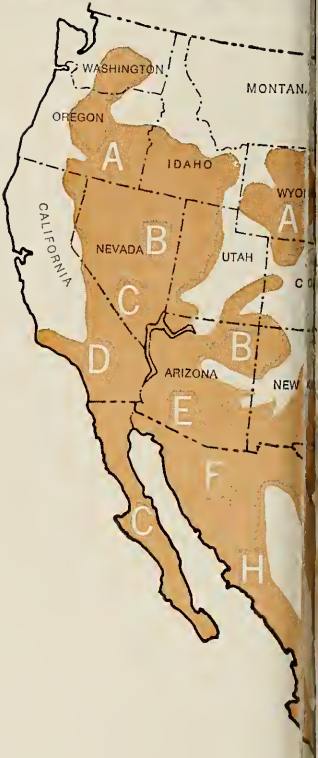
Ecological theory offers the expectation that to the proper herbivores, the shrubs, no less than the grass, would yield ample forage. In one part of Cochise County, Arizona, botanists Bob and Alice Chew found that a representative desert shrub community produced 1,200 pounds of dry matter per acre, per year—twice the annual grass production in many short-grass prairie ranges in the western cattle belt. But in this case, production was mainly in the form of leaves and stems of creosote bush, an energy source that cattle avoid. In these desert shrub communities cattle barely survive even at a population density of from two to six head per square mile.

While cattle and sheep avoid many browse plants, we know from an examination of Pleistocene animal droppings that at least one herbivore of that epoch consumed creosote bush, yucca, and agave. The Shasta ground sloth and other large browsing mammals, such as native camels, disappeared over 10,000 years ago; their niches have apparently not been reoccupied or refilled.

A Pleistocene Perspective

One major objection to the introduction of exotics has been the belief that at the time of discovery by Western man, the New World fauna was in a "natural" state, a balance allegedly struck after millions of years of evolutionary adjustment among plants and animals throughout the Late Cenozoic. Most conservationists believe that to bring in exotics would crowd the native species out of their niches, vulgarize the habitat, and perhaps hazard flooding the countryside with an animal as destructive to native vegetation as the rabbit in Australia and the red deer in New Zealand. At first blush, the arguments against upsetting the natural (A.D. 1492) state of affairs seem thoroughly sound. In terms of the known destructive potential of introduced fish, birds, and small mammals, the arguments are certainly valid. Without careful advance planning and research, the haphazard introduction of any species, large or small, can be challenged. In the words of ecologist Ed Deevey, "we have one witless menagerie in New Zealand and we certainly don't need another."

Yet, by examining the fossil record of the Pleistocene one finds that certain "alien" mammals may have a perfectly valid claim to the continent. If game managers will look at the record with the perspective of paleontologists, they will discover that some of the natives are considerably less American than certain aliens. During the last few million years there has been an active exchange of fauna between America and Eurasia; horses and camels



The presence of the genus Bos, *as a meat producer, and the family Equidae, as a work animal, may have more to do with tradition than with the ecological adaptation of these grazers to the one million square miles of browseland that cover eleven western states and Mexico. In addition to its present crop of domestic livestock, it is suggested that this area might support several million large herbivores, such as the eland, giraffe, and springbok. Predominant browse plants within this rangeland are keyed on map at left. Browseland area includes: Arizona, 80,000 sq. miles; California, 60,000 sq. miles; Colorado, 10,000 sq. miles; Idaho, 50,000 sq. miles; Nevada, 100,000 sq. miles; New Mexico, 40,000 sq. miles; Oregon-Washington, 50,000 sq. miles; Texas, 70,000 sq. miles; Utah, 25,000 sq. miles; Wyoming, 65,000 sq. miles; Mexico, 411,000 sq. miles.*

Rangeland Browse Plants—Western U.S. and Mexico

A. sagebrush
B. saltbush
C. creosote bush
D. chaparral
E. saguaro
F. paloverde
G. mesquite
H. thorn forest
I. thorn scrub

evolved in this continent and spread west, while a variety of bovids, elephants, and deer moved in the opposite direction across the Bering bridge. This exchange involved more Eurasian immigrants than American emigrants. By the end of the Pleistocene (essentially within the last 100,000 years) an Asian horde, including caribou, mountain goats, mountain sheep, muskoxen, moose, and, in Alaska, even *Bos* itself (represented by a species of yak) had immigrated into the New World.

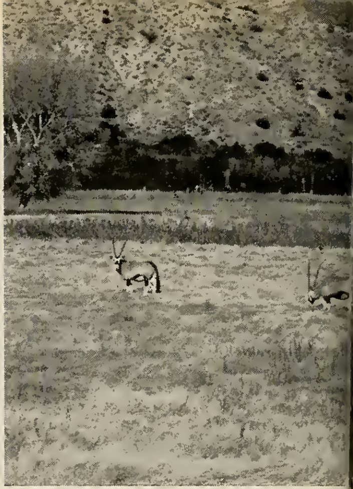
In the perspective of the fossil record, one finds that Asian camels represent a lineage that has a far longer history on this continent than the American bison, a genus that arrived only in the middle of the Pleistocene many millions of years after the American origin of camels. When introduced by the U.S. Army over 100 years ago, the camel demonstrated remarkable adaptability to the American Southwest. Near Uvalde, Texas, on the way to California in 1857, George Beale, an army officer, wrote: "As soon as they [the camels] arrive they are turned loose to graze, but appear to prefer to browse on the mesquite bushes and the leaves of a thorny shrub, which grows in this country everywhere, to the finest grass." Near Devil's River, Texas, Beale wrote of camels eating greasewood (*Larrea tridentata*) with great relish. He noted: "It is certainly very gratifying to find these animals eating, by their own preference, the coarse and bitter herbs, hitherto of no value, which abound always in the most sterile and desolate parts of every road." In northwestern Arizona, he reported that "With all this work they are perfectly content to eat anything, from the driest greasewood bush to a thorny prickly pear, and, what is better, keep fat on it." According to another observer, the Army camel fed on cactus and sagebrush, preferring such food to that which ordinary cattle require. This adaptability would not have surprised the nineteenth-century observers had they known that the camel was merely refilling the niche he had left years earlier.

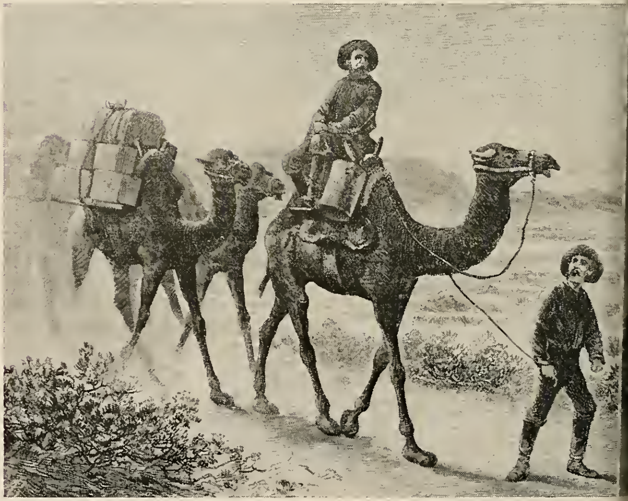
What did cause the extinction of large Pleistocene mammals? In an earlier issue of NATURAL HISTORY and in a recent book (*Pleistocene Extinctions*, P. S. Martin and H. E. Wright, Jr., eds., Yale University Press), I attempted to show that on a world basis the spread of prehistoric big game hunters matches a progressive pattern of megafaunal extinction that began in Africa and southeast Asia and followed the path of the Paleolithic hunters into all parts of the world. But whether or not man was the unique cause of the extinctions, as I conclude, there is still good cause to examine New World ranges on the basis of our knowledge of the fossil record. Niches were suddenly emptied 10,000 years ago; should they now be refilled?

Thorns, Oils, and Browsers

The evolution of arid-land biota began in the Miocene some 20 or 30 million years ago when many mammals increased in size, developed cursorial habits, and evolved high-crowned teeth. At that time desert plants began to evolve defenses against overconsumption by native mammals. One defense may be the terpenes and other repellant oils found in natural concentrations of up to 5 per cent fresh weight in the foliage of many desert shrubs. Those western shrubs not containing repellant oils are typically armed with thorns. Apparently one of these adaptations is used largely to the exclusion of the other—there are few species of desert shrubs that have both spinescence and aromatic foliage. Some shrubs also lose their leaves for a certain portion of each year, another "defense" against browsing.

Range experts have long recognized that the oily, resinous, or thorn-protected shrubs have limited forage value for domestic livestock. In the case of the ubiquitous and unpalatable creosote bush, chemist Peter Duisberg of El Paso found that without its aromatic and highly repellant resins, the plant would be equivalent to alfalfa in feed value for cattle. According to ecologist Linton Gardner of the U.S. Department of Agriculture, if the essential oils of the sagebrush, an abundant shrub over many parts of the West's Great





eral herbivores have been
oduced to the Southwest.
ove: African oryx in New
xico. At left, the camel, a
ve before its Pleistocene
nction, was reintroduced by
U.S. Army in mid-nineteenth
tury. While its food habits
e well adapted to southwestern
erts, its cantankerous
position made it
pular target for the criticism
firearms of frontiersmen.
ow: since introduction of the
ghorn, efforts to improve the
ductivity of western rangeland
e centered on cattle, animals
adapted to most of the land's
y, oily, or woody shrubs.

Basin, could be used in an industrial process that would partly pay the cost of removal ". . . the West would have an almost untouched source of livestock feed." But no inexpensive method of oil removal has yet been found, and both the thorny and oily shrubs continue to spread throughout the desert grassland where they are despised by ranchers as worthless weeds.

The extinction of Pleistocene mammals must have radically altered the dynamics and structure of vegetation in western America. As the niches emptied, the desert plants were left largely uneaten, save for the forage consumed by the small number of surviving large mammals and smaller herbivores. Thus, the removal of the large, browsing herbivores may have permitted the recent spread of "brush" plants, which are of little use to domestic livestock. In Africa, this did not occur since a wide assortment of grazers (zebra, buffalo, wildebeest) and browsers (kudu, giraffe, black rhinoceros) survived the Pleistocene and now provide balanced consumption of both grass and shrubs. In fact, where there are large numbers of elephant, as in Tsavo National Park, Kenya, they bark or topple trees, permitting a "grass invasion"—an ecological shift that American cattlemen might applaud.

The meat production potential of African game has recently been considered by such wildlife experts as Raymond Dasmann of the Conservation Foundation and Lee Talbot of the Smithsonian Institution, who note the superior quality of game relative to beef carcasses. Furthermore, wild game drink less than domestic livestock, grow faster, and can be stocked in greater numbers without damage to the range. Dasmann's study shows that the net annual profit to a rancher cropping game may be three to five times that of raising cattle.

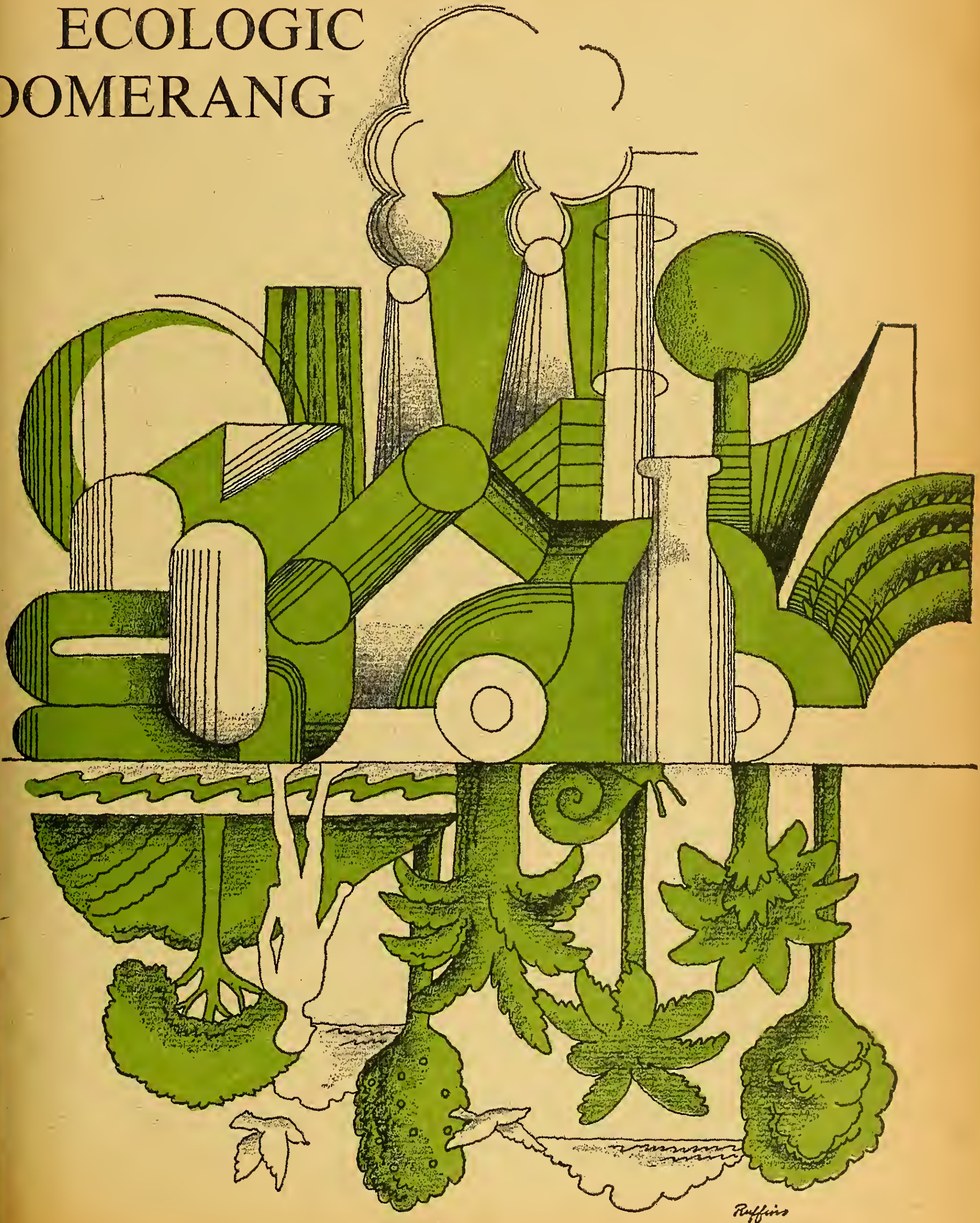
The eland, which Dr. Livingstone a century ago anticipated as suitable for domestication, is now herded with cattle, which forage on grasses. The eland browse on shrubs and trees and the shared range is well utilized. According to Dasmann, eland are more gentle and easier to manage than domestic cattle, grow faster and larger and produce excellent meat. They are already on the way toward becoming an important domestic animal in South Africa. Ecological studies indicate that other strong candidates for African livestock ranching are the giraffe, roan antelope, and springbok. Even elephants may prove superior to cattle as a meat source in parts of the tropics.

In view of the shrub invasion in ranges of the New World, the following remark by Julian Huxley, relating to African range, is especially provocative: "The browsers also prevent the country from turning into an impenetrable thicket." Would the proper assortment of African browsers on New World ranges control the current bush invasion in addition to providing a new source of protein, hides, and fertilizer? Would they restore the greater proportion of grassland that existed at the end of the Pleistocene?

With the development of New World pastoralism through the introduction of domestic animals about 450 years ago, Western man did little to increase forage consumption. Much of the western range industry came about simply through substitution of grazing animals such as cattle and sheep for other grazers such as the bison and antelope. But the browsing niches remained devoid of shrub-consuming herbivores. Browse habitats now prevail over roughly one million square miles on either side of the United States–Mexican border. Theoretically, this range might support 15 to 30 million new animals consuming available energy presently going to waste.

Perhaps massive experiments with alien large mammals is not as dangerous as conservationists sometimes predict. In light of America's unfilled niches and unutilized browse, there now seem to be some good ecological reasons for careful experiments with potentially valuable large African mammals in the New World. "Meanwhile (to quote Ed Deevey in *Pleistocene Extinctions*) to destroy any more ecological order, deliberately, in the interest of propagating cattle, would seem—no stronger word is helpful—simply daft."

HE UNFORESEEN INTERNATIONAL ECOLOGIC OOMERANG



THE UNFORESEEN INTERN

Edit

This Natural History Special Supplement
is based on the conference
The Ecological Aspects of International Development Programs
jointly arranged by the
Conservation Foundation, Washington, D. C.,
and the Center for the Biology of Natural Systems
of Washington University, St. Louis, Missouri,
which was held in Warrenton, Virginia, December 9-11, 1968.

ONAL ECOLOGIC BOOMERANG

hi Farvar, Center for the Biology of Natural Systems, and John Milton, Conservation Foundation

Article Introductions by M. Taghi Farvar

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FRAIL REEDS IN A HARS

Technology is widely credited with many of the good things in modern life: rising agricultural productivity, new sources of power, automated industries, enormously accelerated travel, a vast increase in the volume and speed of communication, spectacular improvements in medicine and surgery. Technology has greatly magnified the wealth that is produced by human labor; it has lengthened our lives and sweetened the fruits of living. All this has encouraged a firm faith that technology is an undiluted good.

There is now at least one strong reason to question this faith: the phenomenon which has just begun to capture the public attention that it merits—environmental pollution. It is beginning to be clear that this assault on the integrity of the environment is the price that we pay for many of the benefits of modern technology. For the advantages of automotive transportation, we pay a price in smog-induced deterioration and disease; for the powerful effects of new insecticides, we pay a price in dwindling wildlife and unstable ecological systems; for nuclear power, we risk the biological hazards of radiation; by increasing agricultural production with fertilizers, we worsen water pollution.

The highly developed nations of the world are not only the immediate beneficiaries of the good that technology can do, they are also the first victims of the environmental disease that technology breeds. We are both the inventors of the new technology, and its first victims.

We are *unwitting* victims of environmental pollution, for most of the technological affronts to the environment were made, not out of greed, but ignorance. We produced the automobiles that envelop our cities in smog—long before anyone understood its harmful effects on health. We synthesized and disseminated new insecticides—before anyone learned that they also kill birds and might be harmful to people. We produced synthetic detergents and put billions of pounds into our surface waters—before we realized that they would not be degraded in disposal systems and would pollute our water supplies. For a number of years we spread radioactive fallout across the globe—before we learned that the resulting biological risks made it too dangerous to continue. We have unwittingly killed thousands of sheep in testing our chemical weapons and have triggered unanticipated earthquakes with our nuclear tests. We are, now, in Vietnam, spraying herbicides on an unprecedented scale—with no assurance that we know their long-term effects on the life of that unhappy land.

Clearly, we have compiled a record of serious failures in recent technological encounters with the environment. In each case the new technology was brought into use *before* the ultimate hazards were known. We have been quick to reap the benefits and slow to comprehend the costs.

One of the great, humane ideas of the technological age is that those nations that have created it should share their knowledge with the less developed parts of the world. In the last generation this worldwide movement to export technology has begun to achieve significant proportions. It has been in this same period of time that we have begun to discover—in the more advanced countries—the hidden environmental costs so often incurred by new technology. Clearly, it would be prudent to examine the record of the technological developments exported to the underdeveloped nations of the world, and to determine how their varied environments have responded to this new intrusion.

This has been the purpose of the Conference on the Ecological Aspects of International Development, which took place in Warrenton, Virginia, on December 9-11, 1968. It is appropriate that the conference was sponsored by two organizations, concerned with the integrity of the environment, that are identified with a highly developed nation: The Conservation Foundation in Washington and the Center for the Biology of Natural Systems of Washington University in St. Louis. For surely, those who offer the boon of technology to their less-favored fellow men ought to be the first to acknowledge its deficiencies. Reports to the conference have brought

ORLD

by Barry Commoner

Director, Center for the Biology of Natural Systems

together, for the first time, a worldwide picture of the effects of new technologies on the environments of underdeveloped nations. Some of these reports are presented in this Special Supplement of NATURAL HISTORY.

The picture is not a pleasant one, but to those of us who are already familiar with the dismaying environmental consequences of technology—smog, radioactive fallout, polluted streams and lakes—it is not surprising.

The parallels between the mistakes made at home and abroad are striking. In the United States, we got into trouble with non-degradable detergents because our narrow, single-value approach conflicted with the intrinsic complexity of the environment; we were concerned only with the detergents' commercial value as cleansing agents and ignored their effects on the environment as a whole. In the region of Kariba Dam, the same kind of mistake was made. As Scudder points out, following an account of the multiple, unanticipated, ecological hazards that accompanied the formation of the lake:

"This project was essentially a unipurpose scheme. The population to be relocated were seen not as a esource but as an expensive nuisance, whose very xistence was unfortunate. As for the future lake, t was strictly a dam by-product, whereas the needs of downriver inhabitants were considered only where backed up by political power, and then were seen as constraints by those who viewed the Kariba Project almost entirely as a means for generating power."

In the United States, our water pollution problems eflect a failure to comprehend the complex, interwoven network of mutually interdependent events hat maintains the integrity of the aquatic environment. As a result, we are surprised to discover that n excess of plant nutrients, dumped into surface waters, stimulates huge algal overgrowths, which ie and become pollutants. As Conway points out, n Malaysia a similar failure to perceive the delicate balance between insect pests and their insect paraites led to huge, unanticipated outbreaks of insect pests *caused* by massive insecticide treatments.

The lesson taught by the environmental consequences of modern technology, both in the advanced and underdeveloped nations, is the same: We need to reassess our attitudes toward the natural world on which our technology intrudes.

Among primitive people, man is seen as a dependent part of nature: a frail reed in a harsh world, governed by immutable processes that must be obeyed if he is to survive. The knowledge of nature that can be achieved among primitive peoples is remarkable. The African Bushman lives in one of the most stringent habitats on earth—food is scarce, water even more so, and extremes of weather come rapidly. The Bushman survives because he has an incredibly intimate understanding of his environment. A Bushman can, for example, return after many months and miles of travel to find a single underground tuber, noted in his previous travels, when he needs it for his water supply.

We who call ourselves advanced claim to have escaped from this kind of dependence on the environment. Where the Bushman must squeeze water from a searched-out tuber, we get ours by the turn of a tap. Instead of trackless wastes, we have the grid of city streets; instead of seeking the sun's heat when we need it, of shunning it when it is too strong, we warm ourselves and cool ourselves with man-made machines. All this tends to foster the idea that we have made our own environment and no longer depend on the one provided by nature. In the eager search for the benefits of modern science and technology, we have been enticed into a nearly fatal illusion: that we have at last escaped from the dependence of man on the balance of nature.

The truth is tragically different. We have become, not less, but more dependent on the balance of nature. Modern technology has so strained the web of processes in the living environment at its most vulnerable points that there is little leeway left in the system. Unless we begin to match our technological power with a deeper understanding of the balance of nature, we run the risk of destroying this planet as a suitable place for human habitation.

A CONSEQUENCE OF INSE

Is it possible that in the development of urgent pest-control measures we may end up with more severe pest problems than those with which we started? Gordon Conway suggests that, indeed, the most serious outbreaks of pests often occur immediately following, and as a direct consequence of, the application of contact-acting insecticides. In Malaysia, the use of chemical insecticides has been known for some time to carry with it twin hazards: the possibility that pest populations will go through a process of accelerated "natural selection," thus developing into a superrace of strong, resistant individuals; and the hazard of toxicity to non-target organisms, such as natural enemies of the pest, other beneficial or harmless creatures, and even man himself. What is less well known is that crises arising from the use of chemical pesticides in the underdeveloped countries have already reached a point more serious than the acknowledged problems in the more developed world.

Very frequently the lack of a cadre of experienced biologists, especially entomologists, means that even if a hazardous situation is recognized, there is little hope that anything can be done in time to avert the consequences. However, a few underdeveloped countries have been fortunate in having

Pests Follow the Chemicals in the Cocoa of Malaysia

by Gordon R. Conway

The basic ecological problem in natural resource development can be described fairly concisely. In a natural-climax ecosystem, the energy received from the sun and the available minerals, gases, and water are converted into a maximal production of living materials; because of the way in which the system has evolved and is structured, this productivity is stable and long lasting. Only a part of the material produced, though, is directly of use to man, and the natural ecosystem becomes replaced by an artificial one where the productivity, measured as yield, comes in a more usable form. Experience has shown, however, that artificial ecosystems tend to be unstable, with long- or short-term deterioration. The ecological problem thus becomes: How can the stable characteristics of the one system be combined with the high-yielding qualities of the other?

Pest control is a special case. In attempting to obtain a high crop yield or a human population in excellent health, we create artificial ecosystems. Nevertheless, elements (pests) from the remaining natural ecosystems continue to intrude. These can in turn be controlled by additional artificial measures, such as the use of contact-acting insecticides; but as we are finding out, such control tends to create further instability—either in the target pest or in other features of the ecosystem. The ecological answer lies in inserting such features of natural ecosystems into the artificial ecosystems as will allow efficient, but more stable, levels of pest control.

In practice, this simply stated solution is often complex and difficult to achieve, largely because of the insufficiency of our knowledge. We urgently require much more fundamental research, for example, on the structure and functioning of natural ecosystems. We need to know precisely and in detail why they are frequently so stable. To what extent and under what conditions do factors such as variety of habitat, complexity of food chain, or climate contribute to stability? We have to understand more clearly why some elements of natural ecosystems, such as certain secondary forest herbivores, rather than others, are more likely to invade and disrupt artificial ecosystems. Above all, we need to learn how the characteristics of stability can be infused into artificial ecosystems without depressing their yields. Does the complexity and organization of the natural ecosystems have to be reproduced in detail or can stability be achieved by the addition of only a few carefully selected features, and if so, which ones? Action on these questions becomes urgent when we realize that many of the world's remaining areas of natural ecosystems are fast disappearing. If we

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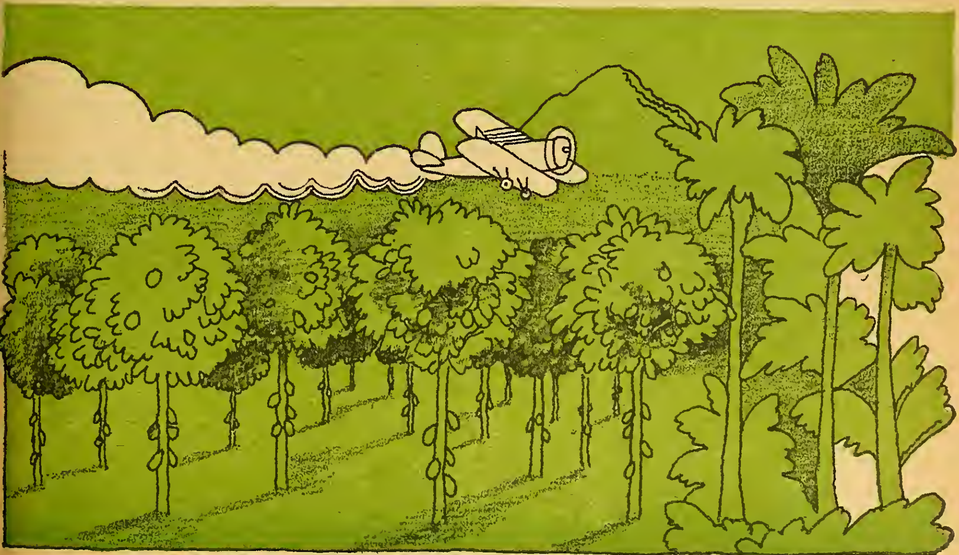
highly qualified personnel capable of recognizing, and sometimes even of acting to alleviate, the problems. Malaysia is such a country. Since the 1920's there has been almost continuous research on Malaysian pests and their control. The predominant ecological and climatic features of Malaysia are those of an almost tropical country—hot and humid. Such tropical ecosystems are extremely complex, a factor that compounds pest problems.

An agricultural ecosystem is an artificial one, in which the productivity of the system is channeled to the output of a very small number of "useful" crops. A plantation system attempts to simplify further the components of an agricultural ecosystem through restricting plants to a single crop. Pest control represents still another step in the direction of simplification. Conway has described the basic ecological vulnerability inherent in the artificially simplified ecosystems of several tropical agricultural plantation systems, and illustrated how the spread and use of the newly introduced contact insecticides inevitably compounds pest problems by interfering with natural control mechanisms. The more frequently such insecticides are used, the more serious are the emerging pest outbreaks. Here is one example involving cocoa.

lose these altogether, the solutions will be even more difficult and in many cases impossible.

After the Second World War the new synthetic insecticides—DDT, BHC, dieldrin, endrin, Malathion, and others—became universally available. Their use in Malaysia grew slowly at first, but has accelerated in the last ten years with the establishment of several vigorous concerns specializing in the sale of agricultural chemicals. The benefits these pesticides have brought have been considerable. BHC, DDT, and dieldrin have been particularly effective against rice pests; in Sabah, dieldrin has provided a cheap and extremely effective means of combating the locust outbreaks that had previously been so serious; and DDT and dieldrin have been the main instruments of the successful malaria-control campaigns. However, my experiences, and those of other entomologists in Malaysia, suggest that the increasing reliance on these pesticides has not been wholly beneficial. Used without regard to the ecological factors of the situation, they may aggravate existing pest problems or create new ones, and they can produce unwanted and far-reaching side effects.

Take cocoa pests in Sabah, for example. Malaysia



comprises mainland Malaya and the Borneo states of Sabah and Sarawak. It lies just north of the Equator. Cocoa is a new crop in Sabah, the first commercial plantings having been made in 1956. Ten years later there were some 6,000 acres under cultivation, mostly in the southeast corner of the state, at Quoin Hill and Tiger, where there are large areas of volcanic soils. In 1958 a research station was set up by the Department of Agriculture at Quoin Hill, and as entomologist in the Department from 1961 to 1966, I was concerned with cocoa pest problems.

The soils that were chosen for cocoa planting naturally support rich stands of primary dipterocarp forest. In the areas to be planted, the forest species yielding commercial timber were first felled and extracted. Some second-story trees and regenerating dominants were left to shade the cocoa, and the remainder were either felled or partially cut and left to decompose. As the cocoa acreage has grown, the primary forest has been pushed back, although the cocoa remains essentially an island within it. Much of the cocoa is thus physically close to primary forest and, in some parts—at the forest edge, along roads, and where there are uncultivated clearings—it also borders on uncontrolled secondary scrub or forest.

The first serious insect pests at the Cocoa Research Station were borers—a ring bark borer, *Endoclita hosei*, which is the larva of a hepialid moth, and two branch borers, *Zeuzera* spp., the larvae of cossid moths. The former tunnels into the young cocoa tree, either at ground level or at the fork, and from the shelter of the tunnel feeds on the bark, girdling the trunk and often killing the tree. The branch borers tunnel along the upper branches and shoots. During their life cycle, they usually make several borings, attacking larger branches as they grow. Attacked branches usually die above the boring site. Initially neither pest was present in large numbers at the new plantings; but the immediate and extensive damage caused by individual ring bark borer larvae made them serious pests in short order. During the first two years of growth, when the cocoa is most susceptible, deaths often amounted to 20 per cent or more per field.

The earliest attempts at control were by hand; laborers were employed to seek out fresh borings and destroy the larvae inside by inserting a wire or by injecting toxic chemicals. This method soon became too costly in labor, and in 1959 spraying with high concentrations of insecticides began. Dieldrin or DDT were applied as high-volume sprays to the branches, fork, and trunk (dieldrin at 15 to 25 ounces and DDT at 12 to 15 ounces active ingredients per acre). Spraying resulted in some degree of control, but the inaccessibility of the borer larvae precluded very high kills.

In 1959 several other pests, including various leaf-eating caterpillars, aphids, and mealybugs, became noticeable. Again, these were present in very low numbers, but they were felt to be a potential danger, and in early 1960, in addition to the spraying for borer control, further general spraying was carried out as a prophylactic measure. Dieldrin, endrin, DDT, BHC, lead arsenate, and a white oil (Albolineum) were variously used, either in combination or alone. Applications were irregular but often frequent, so that during the years 1960 and 1961 the cocoa received a very heavy insecticide coverage.

The situation, however, gradually became worse. First, the branch borers increased, becoming abundant by the beginning of 1961, the incidence of attack rising to one new boring per six trees per month. Not long afterward, outbreaks of three other pests also occurred. Two were leaf-eating caterpillars: one a looper, or geometrid, *Hyposidra talaca*; the other a nettle caterpillar, or limacodid, *Setora nitens,* hitherto known in Sabah only as a major, periodic pest of coconuts. The third outbreak was of a flatid, or plant hopper, *Colobesthes falcata.* All of these became extremely abundant, the hopper so much so that on being disturbed, the adults, which resembled moths, rose in large clouds from the branches. Both the leaf-eating caterpillars caused considerable damage to the young flush leaves, attacking particularly those that were newly green. The plant-hopper nymphs fed by sucking the shoot tips, flower stalks, and young, green pods, although the damage this caused was of lesser consequence.

MALAYSIA
MALAYA
SABAH
SARAWAK
EQUATOR
BORNEO
SUMATRA

In July, 1961, a fourth outbreak, which proved to be the most serious of all, occurred. This consisted of several species of bagworms (Psychidae), the principal ones being two species of *Clania* and an unidentified species of *Mahasena.* Bagworms are unusual insects with a number of characteristics that make them particularly important pests. As the name implies, the larval bagworm lives in a bag of silk, which is skillfully covered with pieces of leaf or short lengths of twig. When it is moving or feeding, only the head, thorax, and legs are exposed. When disturbed, the whole larva quickly retracts into its bag, closing up the open end. The bag is retained throughout the larval and pupal periods; as the larva grows, the bag is extended and new leaves or twigs are added. The adult male is a typical winged moth, but the female is wingless and "degenerate," being little more than a large egg-producing sac that stays within the pupal case inside the bag. Numerous eggs are produced (from 3,000 to 4,000 in the case of the related *Mahasena corbetti*), and they too are retained in the bag. On hatching, the young larvae make their way onto the outer surface of the bag where they quickly proceed o spin their own bags, covering them at first with material from that of the parent. They also produce copious silk threads and with the help of these, are blown away, often over a considerable distance.

The bag gives the insect considerable protection hroughout its lifetime, not only from the weather but also, apparently, from insecticides. In a series of replicated trials with bagworms on sprayed cocoa seedlings, they showed almost complete resistance to DDT, BHC, dieldrin, diazinon, and dimethoate, all applied to run off at 0.25 per cent active ingredient or more. Some feeding occurred in the trials, but apparently the amount of insecticide ingested was not sufficient to cause mortality, while the bags prevented the insecticides from acting through con-act. Removing the larvae from their bags and dipping them in the same concentration of insecticides gave rapid and complete kills.

The damage caused by bagworms is great, since hey are not only voracious feeders but they also hew off large areas of leaf surface to make the bags. As defoliation progresses, extensive dieback of he branches occurs and the trees respond by proliferation of shoots from unaffected buds, which re then in their turn eaten. With extreme defoliation, the bagworms turn to feeding on the bark of he branches and trunks. Because of the reproductive and dispersal characteristics, outbreaks are typically in the form of explosions that radiate from central focus.

The outbreak of 1961 began in one field at the Cocoa Research Station and rapidly spread in this ashion. By late 1961 some 70 acres were affected, nd repeated defoliation had produced large numbers of bare and dying trees. Spraying with DDT, ieldrin, and the other insecticides continued hroughout 1961, but the bagworm outbreak persisted unaffected. Some attempt at hand collection was made, but this proved ineffective and very costly. The other outbreaks also continued, with the exception of the nettle caterpillar, *Setora nitens*, which died out in September.

Then, toward the end of 1961, with the pest situation extremely serious, a decision was made to stop the spraying. This was based upon a number of considerations. First, although some pests had been present since the beginning of cocoa planting, it was only after the introduction of the heavy spraying program that the major outbreaks occurred. Second, nearly all the insecticides used hitherto were of the broad-spectrum, contact-acting type: that is they killed most insects that came in contact with them. Since parasitic and predatory insects tend to explore widely, they are more likely to contact insecticide deposits than are pest insects, particularly when these are relatively stationary leaf-eating caterpillars. Differential mortality can thus occur, and the pest species are able to break out from the natural control exerted by their predators. It was felt that even if this was not the cause of the outbreaks on cocoa, the chances were that the spraying was preventing any possibility of natural predators re-establishing control.

The level of spraying was reduced in October and finally stopped in December, except for two fields with exceptionally severe bagworm infestations, which were sprayed twice more in January and February. The event that followed almost immediately was the appearance of a braconid parasite, a species of *Apanteles*, attacking the looper *Hyposidra talaca*. Some twenty or more parasites developed in each looper larva and at maturity emerged to form dense clusters of whitish cocoons visible everywhere on the cocoa trees. The rapid increase in this parasite caused the looper population to drop suddenly. It remained low until May when it flared back, only to be followed by another parasite buildup. Within three to four weeks, the population had again declined, this time to a level at which damage was negligible. In April and May it became evident that the plant hopper *Colobesthes falcata* also was declining rapidly. In this case the cause was not obvious, although there was some evidence of predation and an entomophagous fungus was present. The decline continued, and by August the hoppers were present in only very small numbers.

The next pests to come under control were the branch borers. These had persisted in abundance through the first half of 1962, continuing to inflict severe damage. But in August a decline in new borings became noticeable, and when a sample of borings was opened and examined, it was found that over 50 per cent of the branch borer larvae were parasitized by braconid wasps, mostly belonging to the genus *Iphiaulax*. The population continued to decrease rapidly; at the end of September few new borings were to be found, and by the end of the year, the damage was infrequent.

Following the cessation of spraying, it was felt that the damage caused by the looper and plant hopper, and to a lesser extent by the branch borer, could be tolerated without taking any action other than waiting in the hope that natural control would be re-established. However, the damage caused by the ring bark borer and by the bagworms was too severe to be ignored for any length of time, and attention was turned to finding selective means of control for these pests, which would not interfere with any natural control being re-established over the other species.

As has been mentioned above, although the ring bark borer damage was severe, the population was not very large; and toward the end of 1961, it was decided to revert to inspection and eradication of individual borers. More labor was now available for this form of control since the general spraying program was being stopped; small teams were organized to inspect the cocoa and treat new borings with a jet of 1 per cent dieldrin from a hand sprayer. Since the life cyle of the ring bark borer is very long, probably up to a year in duration, it was thought that an initial blitz of two inspections a month, followed by others at monthly intervals, would serve to bring the population down to tolerable levels, which could then be maintained by much more infrequent inspections. By applying the insecticide in this extremely localized fashion, there was also little possibility of affecting the natural enemies of the other pests. At about the same time, it was discovered that an important, alternative host of the borer was a secondary forest tree, *Trema cannabina*, which was not only common in the cocoa fields but, along roadsides and in other areas, was present in nearly pure stands. Inspection revealed that many of these trees supported considerable numbers of borers living in a complex of tunnels. In the fields the trees were acting as focuses for the infestations in the cocoa and, therefore, as a complement to the inspection program, steps were taken to eradicate *Trema* from the cocoa and from much of the surrounding areas. Combining these two measures proved immediately effective, and borer damage dropped off rapidly. From 1962 onward, mortality in new plantings during the first two years was usually well below 0.5 per cent.

In the case of the bagworms an intensive search was carried out in the hope of finding a selective insecticide that would give control. Finally, in March of 1962 samples of trichlorphon (Dipterex) and of a preparation of the bacterium *Bacillus thuringiensis* (Thuricide) were obtained, and in a series of trials with sprayed cocoa seedlings were found to give rapid and complete mortality. Trichlorphon had been shown elsewhere to have considerable selective properties; it is only of moderate toxicity to such insects as the parasitic wasps and it is a persistent stomach-acting insecticide with only short-lived contact action. *Bacillus thuringiensis* similarly is selective, causing mortality mostly to larvae of lepidopterous pests, such as the bagworms. Of the two, trichlorphon was the more readily available, and a high-volume test spraying of an infested field with 0.25 per cent spray appeared to give a very high kill. Regular monthly spraying of the infested 45 acres at the Cocoa Research Station was thus begun in May, the trichlorphon being applied at about 3/4 pound active ingredient per acre. The treatment brought about an immediate effect; the bagworm population dropped rapidly and the trees began to recover, putting out new flushes of leaves that were able to survive. But it became evident that kills were not so high as they had first appeared (probably not much more than 75 per cent) and the hope of obtaining complete control with two or three applications was not realized. Regular spraying was continued, though, and gradually control was obtained, the population dropping lower each month, with occasional mild resurgences. By April of 1963 the population was very low, the damage insignificant, and the sprayings were stopped.

Thus, during 1962, most of the pests, which had been so important in 1960 and 1961, had succumbed to natural control of one form or another or, in the cases of the ring bark borer and the bagworms, had come under effective and selective artificial control. In 1963 artificial control was no longer needed against the bagworms, and the high incidence of parasitic tachinid flies in the remaining individuals suggested that the tachinids were now responsible for keeping the bagworms in check. Significantly, in the subsequent five years, none of these pests have built up again.

The commercial cocoa estates at nearby Quoin Hill were urged to follow the example of the Cocoa Research Station, and in early 1962 most of them abandoned the use of contact-acting insecticides. Their experience was the same: most of the outbreaks died out rapidly in 1962, and these pests have remained at low, insignificant levels ever since. They also adopted the control measures devised against bagworms and the ring bark borer and experienced similar success. Only on one estate which persisted in the use of contact-acting insecticides, has the situation been different; this particular estate has continued to be plagued not only by branch borer damage but also by periodic out breaks of bagworms and other leaf-eating caterpillars.

All the insects on cocoa in Sabah, including the pest species, are indigenous. Originally, it was thought that they had come from the primary forest. But in 1961, as has been mentioned, the ring bark borer was found in large numbers in the secondary forest tree *Trema*. The evident tolerance of the borer shown by this tree strongly suggested that it was a primary and original host and raised the possibility that the other pests had similarly come from the secondary forest. On examination it was found that several secondary forest trees, such as *Macaranga* and *Acanthocephala*, were common hosts of the ring bark borer and of the plant-hopper, and that several of the other pests were also present on occasion. A search of the literature showed that in other countries where wild hosts of the Sabah pest species have been recorded, these hosts were predominantly or exclusively secondary forest, or in some cases riverine, plants. None of this is, of course, very strong evidence. Secondary forest growth is widespread and easily inspected, which may account for the predominance of records. Until more is known of the fauna of the primary forest and particularly of the canopy foliage, the question cannot definitely be resolved. However, this rather circumstantial evidence is also backed by certain theoretical considerations.

Most of the plants of the secondary forest and of such situations as riverbanks and roadsides are essentially fugitive species. They have well-developed powers of dispersal and reproduction and grow vigorously so that they are able to rapidly colonize newly available sites. They are also hosts to many insects which must be adapted in the same way to this special situation.

Clearly, possession of these characteristics pre-adapts these insects to the role of crop pests. Many cocoa pests in Sabah possess them to some degree, and from this alone there is reason to accept that they have come from the secondary forest habitat.

But to see the secondary forest as a source of potential pests only is to see but part of the picture. Undoubtedly it also supports their natural enemies; on reflection it would seem logical that they, too, in their adaptation to this habitat will show the characteristic fugitive features of well-developed powers of dispersal and habitat (host) finding, together with a high reproductive rate and some degree of polyphagia (ability to live on several hosts).

In nature, destruction of part of the primary forest may result from earthquake, lightning, whirlwinds, or flood, or perhaps more commonly, from the natural death of an emergent, which in falling brings down its neighbors. Whatever the cause, this destruction will create a habitat for fugitive species and initiate a secondary forest succession. First the bare area will become rapidly colonized by herbaceous and spreading plants and then, after an interval, the first herbivorous insects will arrive. As the latter multiply, they will, in turn, be found by parasitic and predatory insects; the numbers of these will increase and those of the herbivores decrease. But the flora of the area will also be changing; the first colonizers will be replaced by other secondary forest species, shrubbier in form and more competitive. Some of the first insects will be able to move onto these, but the new plants and the new microhabitats they create will also be favorable for a second wave of fugitive insects. In the hot, humid climate of Malaysia conditions will be almost continuously favorable for the growth and reproduction of these plants and insects. And so the succession will go on with new waves of colonizing plants, and herbivorous insects and their enemies, each exploding briefly and dying down.

Apparently, the clearing of the primary forest and the planting of cocoa in Sabah has resulted in a somewhat similar chain of events. The bare areas following the felling of the forest have become colonized by secondary forest plants and by the transplanted cocoa seedlings. Fugitive insect species have moved in, attracted to the secondary growth plants, and because of their generally polyphagic habits to the cocoa as well. There, as a result of the damage they caused, some become pests. But at this point the picture was complicated by the intrusion of heavy applications of contact-acting insecticides. In effect these seem to have either prevented the expected natural enemies from entering the crop or destroyed those already present and exercising some degree of control. Many of the pests, in consequence, instead of exploding briefly and dying out, continued to multiply, producing major and prolonged outbreaks. It is significant that in the cocoa-growing area at Tiger, in Sabah, where this type of insecticide was used much less, the major pest outbreaks did not occur, although there has been damage from the branch borers and from such low-density pests as the mirids and the ring bark borer. At Quoin Hill cessation of the spraying at the end of 1961 appears to have corrected the situation. The major outbreaks have come under natural control, leaving only a few pests, damaging at low densities, that required selective, artificial control measures. As the cocoa has grown older and the microhabitats have changed, other pests—as was to be expected—invaded the crop. But the absence of contact-acting insecticides has meant that, for the most part, these have come quickly under effective natural control, leaving again only the low-density pests in need of attention.

THE LIMITATIONS OF MIL

Gordon Conway dealt with the consequences of altering a complex natural system in a tropical setting, where the ecosystem was simplified to force it to produce more products directly useful to man. This was done by removing from the initial, complex biological system all non-useful items, and leaving or introducing only those for which man is eager. We saw that simplification of the biological system means the substitution of an essentially mercurial and vulnerable system for one that was basically stable. For example, the plantation system in Malaysia meant not only that the productivity of one or of a few desirable plant species was stepped up, but also that the numbers of the various pests specific to these crops tended to explode. This was particularly true when the attempt to subdue the pests (to further simplify the system) removed their natural enemies, enabling the pests to multiply astronomically.

In the following two cases, there is a parallel concern. Here our ecosystem is the internal metabolic environment of man, and its interaction with the external environment through the steady inflow of various nutrients—food and drink. The initial stability of the system (in the same dynamic sense) is usually attained through prolonged adaptation to these inputs. The evolution of cultural patterns further stabilizes the relationship between man and his environment. The introduction of new items into man's food regimen represents an external disturbance of the former balance between nutrients and the metabolic processes. Dr. Bunce documents one such disturbance in the metabolic process in northeast Brazil, a region where vitamin A deficiency at present approaches epidemic proportions. Here, where the population is predisposed to any aggravation of vitamin A deficiency, an attempt to introduce dried milk did actually aggravate the symptoms of avitaminosis. The sudden availability of protein caused the individual to experience growth. This led to a rapid depletion of the already meager supplies of vitamin A, which were removed from the liver as a protein complex. The results, as well as they can be determined, were outbreaks of night blindness,

Milk and Blindness in Brazil

by G. Edwin Bunce

Malnutrition is one of the most serious problems facing the world today. The FAO in its Third World Food Survey estimated that at least 20 per cent of the population of the developing countries are undernourished and that about 60 per cent consume diets that are inadequate in nutritional quality. Despite considerable efforts to feed the hungry, we are failing. Today more persons are hungry than ever before in the history of the world.

Many laymen are aware of the basic facts of good nutrition and the need for adequate daily supplies of the various macro and micro nutrients. Most are unaware, however, of the relationships among nutrients or between nutrients and environmental factors. Moreover, conventional medical training and practice in this country often ignore many of these interdependencies, which affect markedly the physiology of the consuming organism. Such interactions are the rule rather than the exception.

In order to illustrate this point more fully, let us consider the case of the interrelationship of protein and vitamin A, two nutrients in deficient supply in many populations that have severe deficiency symptoms. Vitamin A is one of the class of fat soluble vitamins. It participates in a number of biochemical processes and is necessary for a normal rate of growth, for night vision, and for the health of epithelial structures of the eye, the respiratory tract, and the gastrointestinal tract. A mild deficiency of vitamin A may result in the inability to see in dim light, growth retardation, and a dermatosis characterized by dryness, roughening, and itching of the skin. If the deficiency is more severe, the conjunctiva and para-ocular glands become abnormal and unable to produce their usual supply of lubricating fluids. This condition, called xerophthalmia, may be readily followed by secondary infection, ulceration, softening of the cornea (keratomalacia), and perforation. If therapy is begun at the stage of uncomplicated xerophthalmia, the prognosis is good. Otherwise, partial or total blindness is likely to result. Vitamin A deficiency is common in underdeveloped regions, and particularly prevalent in urban slums.

Protein is one of the macronutrients. Proteins are large polymeric molecules formed from smaller compounds called amino acids. Protein serves a

ture's Perfect Food—For a Few

xerophthalmia (the drying of the conjunctiva and para-ocular glands in the eye), keratomalacia (softening of the cornea), and irreversible blindness. Dr. Bunce warns that such complex nutrient interreactions are more the rule than the exception. Any attempt to improve dietary composition in the underdeveloped countries must therefore be viewed as potentially disruptive of normal metabolic functions, and studies must be undertaken to try to predict and evaluate the consequences of introducing foods of no previous ecologic relevance.

In another instance, Drs. Davis and Bolin of Australia point to mounting clinical evidence that not even such a seemingly harmless item as regular milk can be assumed to be safe for introduction into the underdeveloped countries. Large investments have been made recently in countries such as India and Korea for modern dairy industries. The objective is to provide milk and other dairy products for local consumption. It is now evident that the absorption and digestion of milk is dependent on the presence of the enzyme lactase, and cannot take place in probably a majority of the people of the underdeveloped countries. Lactase is needed to break down the double-sugar lactose (the main carbohydrate of milk) into two simple sugars, glucose and galactose. In a large number of the world's peoples, as well as in most other mammals, production of this enzyme in the gut gradually ceases once the infant stops ingesting mother's milk. Therefore, food aid programs, which more often than not depend on the distribution of dried or fresh milk, risk producing the reactions of milk intolerance, ranging from bloating and abdominal pains to severe diarrhea. One can visualize an emergency food aid program, in an area devastated by an earthquake, flood, or famine, in which huge amounts of dried milk are rushed in to feed the starving victims. The inducement of diarrhea, in a population already severely debilitated, would carry the danger of eliminating whatever other nutrients might have been available to the distressed victims. Thus, the nutritional drain, despite the good intentions of donor agencies, might simply become amplified.

structural role as the primary material of muscle and other cells and is required for the production of enzymes. Protein deficiency (kwashiorkor) and protein-calorie malnutrition (marasmus) are the two most widespread nutritional deficiencies in the world today. Failure to consume adequate amounts of protein and calories leads first to growth failure, followed by wasting, secondary infections, and death.

The relationship between deficiencies of vitamin A and of protein is complex. Animals fed a good protein diet apparently consume their body stores of vitamin A rapidly and develop eye lesions at an earlier time than slower-growing littermates fed rations low in protein. Clinical evidence with human nfants similarly shows that children with grossly retarded growth often have no ocular lesions despite ow vitamin A intakes and blood levels, but they may develop xerophthalmia if vitamin A supplements are not included with the treatment for protein malnutrition. The picture is further complicated by the fact that serum proteins act as carriers for vitamin A in the blood; thus, mobilization as well as utilization of stored vitamin A may be stimulated by protein supplements in children previously receiving low-protein diets.

With this information as background, one may speculate that prolonged intake of a marginal level of both vitamin A and protein could result in a juvenile population in which growth retardation was present, but not severe, and the body reserves of vitamin A were minimal. Sudden famine, brought on by drought, floods, revolutions, etc., would precipitate protein-calorie malnutrition, but the concurrent acute growth restriction or weight loss would prevent the outbreak of visible signs of vitamin A deficiency. Distribution of a high-quality protein low in vitamin A to children in this state would yield a spurt of growth and rapid mobilization and consumption of the remaining body stores of vitamin A. The acute stage of vitamin A deficiency with its potential for partial or total blindness might then follow.

The likelihood that such a series of events might occur was very real up to the early 1960's, since one of the major foods employed in famine relief was skim milk powder, a good-quality protein low in vitamin A. Relief agencies often insisted upon distributing vitamin A capsules along with milk powder, with instructions that the children might lose their sight if they did not take the capsules. However, the number of children who received the vitamin A, as suggested, is not known. One may

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presume it likely that these warnings were ignored or forgotten by many uneducated and destitute parents. However, few instances of widespread and serious complications are known. Perhaps most recipient populatons were not in the state of balance required to be susceptible in large numbers. Perhaps the vitamin A capsules were consumed more faithfully than one might anticipate. On the other hand, the difficulties of obtaining reliable medical statistics may have obscured the true incidence.

In at least one instance, protein supplements seem to have aggravated chronic vitamin A deficit. In the late 1950's several severe droughts occurred in northeast Brazil, where deficits of both protein and vitamin A are serious, well established, and of long standing. Thousands of country people migrated to Recife and other cities seeking work. Epidemic outbreaks of xerophthalmia and keratomalacia were reported from Recife, coincident with distribution of dried skim milk to famine victims. Carefully documented evidence of this event is not available, but first reports have been supported by subsequent interviews with competent authorities.

Recognizing the potential hazard of separate consumption of vitamin A supplements and skim milk powder, UNICEF and other agencies encouraged research on additives that could be mixed with the milk powder. A stable, water-dispersible vitamin A derivative was developed by chemists in the early 1960's. Tests with rats showed the additive to be effective even with low fat intakes. However, the possibility still remained that humans in the affected area might respond differently because of unsuspected variations in conditions (such as parasite loads or chronic deficiencies), and it seemed advisable to study recipient subjects to assure safety and effectiveness under field conditions. Data from these studies supported the animal tests and encouraged the widespread employment of the additives in human feeding programs.

Milk Intolerance in Southeast Asia

by A. E. Davis and T. D. Bolin

The phenomenon of lactose intolerance is drawing increasing attention as its implications for food aid programs become clear. A considerable racially linked incidence of such intolerance, due to primary lactose deficiency, has been described in studies of Negroes, Australian Aborigines, and Greek Cypriots, and has been suggested for Indians, as well as for other Asian ethnic groups. When we realize the important role of milk and milk products in food aid programs to underdeveloped Asian countries, the socioeconomic implications of a high incidence of lactose intolerance among Asians become clear.

In times of famine, milk aid programs are instituted. At such times also, gastroenteritis and protein-calorie malnutrition are prevalent. These latter conditions are important secondary causes of lactase deficiency. Thus, if a primary lactase deficiency exists in the population, symptoms following the ingestion of lactose may be very severe. Milk, in amounts contributing a significant nutritive part of the diet, may, for example, cause diarrhea or exacerbate the diarrhea already present in a debilitated child. In infants with normal intestinal mucosa, it is accepted that lactase deficiency with lactose intolerance is a congenital hereditary defect, with recessive inheritance most likely.

The results of studies on both animals and humans are inconclusive, but seem to us to favor the theory that lactose intolerance is due to a gradual decline in enzyme activity because of the lack of a continued substrate challenge in the form of milk or milk products. This theory would account for the earlier appearance of the condition in some ethnic groups whose milk consumption after weaning is minimal, compared with Caucasians whose milk consumption declines only at a later age. A direct relationship of age to an increased incidence of lactose-induced cramps and diarrhea in Negroes also is supportive of this theory.

A post-weaning decrease in lactase activity occurs in most mammals. A number of experiments have attempted either to influence the rate of the normal post-weaning decline or to provoke the return of lactase activity in the adult animal. These are open to various interpretations; but while they are admittedly controversial, we feel that these animal experiments point to enzyme adaptation and, therefore, favor an acquired, rather than a genetic, mechanism for primary adult lactose intolerance.

Studies of human subjects again illustrate the controversy over the genetic or acquired nature of lactose intolerance. Cuatrecasas, Lockwood and Caldwell (1965) showed in a group of sixty patients, 67 per cent being Negro, a strong correlation between milk consumption and lactose absorption. Whereas 86 per cent of non-drinkers of milk were lactose non-absorbers, only 13 per cent of milk

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I believe that the agencies involved in the food relief programs for northeast Brazil made a reasonable effort to minimize the dangers of aggravated vitamin A deficiencies. The value of this example lies in its warning of the necessity for careful planning with nutrition experts before beginning projects dealing with food distribution. For instance, if an administrative decision had been made to economize by omitting vitamin A supplements altogether—on the grounds that few cases of xerophthalmia were being reported—it might have seemed quite sound to a person unfamiliar with the nutritional history of northeast Brazil and the interrelationship of these two nutrients. Yet, it could have caused immense suffering.

Nutrient and environment interdependencies are not rare in the study of nutrition. The failure to produce niacin deficiency in rats fed diets similar to those consumed by human pellagra patients was not understood until research revealed the rat to be about twice as efficient as the human in converting the amino acid tryptophan to niacin. Recent studies in Africa and the West Indies have shown that magnesium deficiency is frequently induced secondary to protein deficiency and must be considered in the therapeutic program for maximum success in treatment. Studies from South America and Tulane University indicate that the type of dietary carbohydrate may be of major significance in determining the response of a human to various parasitic species.

The interaction between vitamin A and protein resulted in the northeast Brazil experience of aggravating a vitamin A deficit by the feeding of high-protein supplement. Such interactions are not readily obvious. Since nutrient interrelationships are common and may have profound effects if ignored, the many factors in dietary patterns should be considered before changes are put into effect. At the least, this will be an attempt to minimize the potential for unsuspected and tragic results.

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drinkers were non-absorbers. An attempt to increase lactose absorption in seven non-absorbers was made by giving 150 g. lactose daily for up to 45 days. There was no increase in lactose absorption or jejunal lactase activity. However, animal experiments suggest that at least nine weeks are required for lactose loading to result in enzyme induction. It is also possible that lactose alone is insufficient to provoke enzyme induction in humans. Lactose is a component of oligosaccharides in milk, and it may be that these or some other fractions of whole milk are essential for continued enzyme production.

A significant fall in lactose absorption was found in two patients deprived of milk for five months, suggesting a decline in enzyme activity with the disappearance of continued substrate challenge.

Cook and Kajubi (1966) found an "inherited congenital" difference in lactase levels between different African tribes. Lactase deficiency is very common in the Baganda, occurring in 89 per cent. However, their diet is largely vegetable, mainly banana. Milk consumption was either nil or less than one-fourth pint daily. In contrast, the Bahima tribe "took between 2 and 7 pints of milk daily and little else." Here, then, are two tribes, one of milk drinkers who are lactose tolerant, and the other who do not drink milk and are nearly all lactose intolerant. We would interpret this as evidence more in favor of an acquired, rather then a congenital, defect.

Our own study shows lactose intolerance to be common in Chinese students, New Guinea natives, and a small group of Indians. A total of 29 out of 30 Chinese students were found to have lactose intolerance. All the New Guinea natives were lactose intolerant as were four of the five Indians. One Caucasian had a maximum rise in blood sugar after lactose of 20 mg./100 ml. However, he did not have diarrhea and had normal lactase activity.

While these problems are being conscientiously tackled, it would appear that there has as yet been no comprehensive survey into the medical effects of increasing the milk content of the Asian diet. The little evidence available at the moment would suggest that only children under six would benefit, at least initially. What is required is a survey of lactose intolerance among Asian peoples in their own environment. This survey has to answer certain questions. What is the over-all incidence of lactose intolerance in the various communities? What is the incidence in relation to the age and previous milk-drinking habits of these peoples? Is the defect congenital or acquired?

The results of such a survey would show which communities—and which groups within an individual community—would benefit most from the introduction of milk products into the diet. If the defect could be shown to be an adaptive phenomenon, then milk could be introduced into the diet under a planned scheme aimed at gradually increasing the lactose content of the various milk products. If, on the other hand, the defect is genetically determined, then it would appear better to concentrate on other ways of improving the value of the basic diet.

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THE OVERHEAD SPRINKL

Irrigation is an attempt to artificially improve the productivity of an agricultural ecosystem by supplementing the supply of water, the most basic life-sustaining substance. As a result of this changed provision of water, the environmental components of the system change, leading, in turn, to biological modifications. One of the most dramatic achievements of man in arid regions is the creation of oases in the desert. Professor Rivnay describes several cases in which crops introduced into the desert were infested by pests that had migrated to the site of the new plantings from as much as hundreds of kilometers away. Peaches and grapes planted at Sdeh-Boker, in the desert's midst, were soon attacked by their respective pests. Examples of other consequences of technological intrusion into desert environments are also described, after a brief description of changes in irrigation techniques over the decades in Palestine. In the last section of this condensed version of Professor Rivnay's paper, we see a striking example of how several insects of no previous importance have today risen to the status of notorious pests, necessitating extensive control measures and causing serious agricultural losses. These are the result of either a change from traditional dry farming (as in the case of outbreaks of seed-corn maggots now attacking such diverse crops as cucurbits, peanuts, beans, cotton, or corn), or a change from furrow irrigation to overhead-sprinkling techniques (as in the case of the red pumpkin beetle, which also

How to Provide a Nice, Wet Place Where Insects You Don't Want Thrive

by E. Rivnay

For centuries the sources of water for irrigation in Palestine were springs, rivers, and wells in which only upper level water was exploited. Distribution of water was in open canals, and irrigation took place in lands lying lower than water-collection pools.

Early in this century, pumps driven by gasoline engines were introduced; later, deeper drilling capacity and improved pumps made collection pools unnecessary since the water was pumped in closed pipes from long distances. These new sources of water made possible the expansion of areas under irrigation. Permanent pipelines were laid in large fields and summer field crops sown. Corn, alfalfa, and fodder beets were grown, as was stone fruit. Citrus groves multiplied. In the 1930's, a pipeline was extended from the springs of the Yarkon River to the semiarid northwestern Negev. With water driven to the Negev by pump, the land under irrigation made possible the establishment, in 1939, of eleven new settlements in the midst of the desert.

After World War II, light, portable irrigation pipes were introduced. At first, perforated pipes were employed for overhead irrigation. These were replaced by a variety of sprinklers. The light pipes enlarged the areas under irrigation even more. Field crops, vegetables, and trees now covered large tracts of land. Where sprinklers didn't work, openings were cut in the pipes, from which water in regulated streams ran in furrows, irrigating both trees and field crops. After the establishment of the State of Israel, cotton, peanuts, and sugar beets occupied large areas, and commercial plantations of such tropic fruits as avocado and mango were planted. During that decade, another irrigation enterprise on a large scale was undertaken: the draining of Hula Lake and its adjacent swamps and the transfer of some of the Jordan waters.

During the present decade other exploitable sources of water are being avidly sought: runoff rain waters are blocked, pumped, and poured over the sand dunes to replenish underground stores of water; deeper drillings are made in arid areas; purification of sewage waters is planned; and efforts are being made to desalinize and exploit sea water.

The benefits to Israel of all these efforts are obvious. Large new areas are brought into cultivation and new crops are possible. In some cases, repeated sowings are possible; in others, the period of a single stand may be prolonged. Overhead sprinkling saves expensive labor, and allows unskilled labor to be employed in agriculture. It also allows the irrigation of slopes and other areas where furrow irrigation is difficult or impossible.

S OF ISRAEL

attacks other cucurbits). These modifications in the insect fauna are triggered by the soil's becoming a more favorable environment for the eggs and larvae of certain pests. It is important to notice that while other countries are imitating the introduction of such new techniques as sprinkling irrigation, very little is being done to study, let alone control, the profound changes in the insect pest ecosystems of such artificially watered regions in arid lands. In Algeria, for example, overhead irrigation (aspersion) is now practiced on a very large scale. It is known there that this system of irrigation causes acceleration of salt accumulation in the topsoil, since a great deal of water intended for crops necessarily evaporates before reaching the ground in the very hot conditions south of the Atlas Mountains. Most of the water available in the Sahara is naturally very salty, and by the time it reaches the soil it is more concentrated in salt content; in this way much land is lost to agriculture through salinization. Nothing much, however, is known about the precise changes that must be occurring in the population dynamics, physiology, and ecology of the pests found in these fields. It can only be reasonably speculated, in the absence of such studies, that the changes, often seriously adverse, in the pest populations described in the following paper, might be even more drastic in the generally more severe heat and aridity of the environment of the North African desert oases and agricultural colonies.

But each alteration in irrigation technology has brought with it unforeseen difficulties. As the well-known entomologist Uvarov said, "When irrigation is introduced into a desert an oasis is made which will soon be invaded by pests specific to the crops raised." What follows are some of many recorded instances where insect pests have followed on the heels of technological improvements.

Extension of Areas Under Irrigation

Spodoptera littoralis, formerly known by the name *Prodenia litura,* is a notorious pest in Israel. It is of foreign origin and probably entered the country early in this century, apparently from Egypt, where it first appeared in the 1870's and quickly assumed a role of primary importance to Egyptian agriculture. In Israel the rise of this moth was far slower. It was hardly known before the 1920's, when its damage was recorded only during the months from June to August, the period of its population peak (Bodenheimer, 1930). For over two decades this status changed only a little, but since the late forties the populations of this pest have increased, the period of activity and recorded damage extending until October and November. The host list, moreover, has increased to include grapevines and apples, which had not been attacked before.

One reason for this pest's change in status lies in the irrigation-induced changes in agricultural practices. Not only were the alfalfa areas increased, owing to the use of the portable irrigation lines and the initiation of the manufacture of alfalfa meal, but also new crops were introduced. Peanuts, cotton, and sugar beets, which had not been grown before, became key crops in this new agricultural economy. These four industrial crops, which grow in the arid summers only because of irrigation, offered food to the polyphagous *Spodoptera* continuously from May until late in November; when one kind of crop dried out, another was still fresh a short distance away.

The lands upon which the irrigation crops now grow were covered, in the past, with dry-farming crops that did not attract *Spodoptera* moths. In June, when the population of the pest had become active, the wheat, chickpeas, lentils, and other crops had matured and dried. Those that were still fresh, like sesame, had not been watered and, therefore, did not attract moths. As is the case with other noctuid moths, the females of *Spodoptera* are especially attracted to recently irrigated fields.

The extension of areas under irrigation also caused the increase of monophagous pests. The weevil, *Hypera variabilis,* a pest of alfalfa, which was hardly noticeable in Israel in the early thirties, became a pest against which control measures are practiced now (Melamed, 1963). This holds true also for the beet weevil *Lixus junci,* whose rank as a pest changed after sugar and fodder beets began to cover large areas under irrigation.

Before irrigation was extended in Israel, onions were grown in the winter by planting sets from previous years. Rains supplied the necessary moisture, and the bulbs matured and were harvested in June. Today, as a result of irrigation, seed is sown in September and October. The soft seedlings are re-

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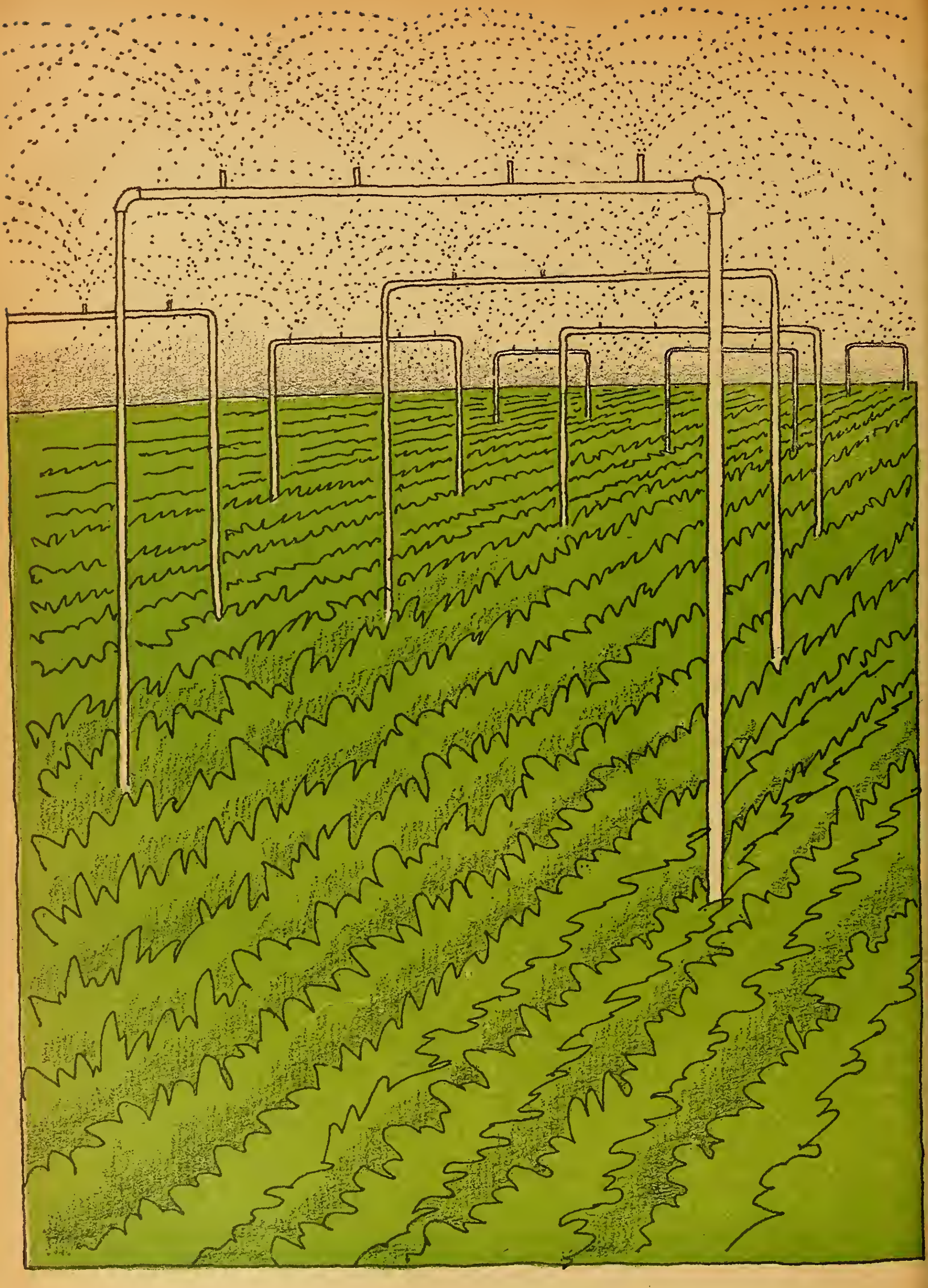


planted in the fields, but they are less resistant to fly maggots than the onion sets used in dry farming. The onion season is thus lengthened; onions are already in the fields by October or November.

Until two decades ago, the onion fly *Hylemyia antiqua* was considered a pest of little importance; no insecticides were necessary, as its damage was hardly felt (Bodenheimer, 1930). But with the new methods of cultivation resulting from irrigation, this fly has become conspicuous, thereby necessitating measures of control.

In Israel, as in colder European and North American countries, this fly raises two or three generations annually. According to Yathom (1963), the estivating generation of the fly emerges from diapause in November and December. The offspring of this—the autumn—generation matures in the middle of the winter and gives rise to the winter generation, which enters diapause in the pupal stage. The early individuals of this brood may continue to reproduce, and only their offspring will enter diapause. Records of appearance of the generations are given in detail because to explain the increase of the fly population due to irrigation we should point to the synchronization between availability of host plants and the awakening of the fly from diapause.

In the case of dry farming, there were no host plants upon which to oviposit when the flies of the estivating generation emerged from diapause; many, especially the earliest, perished before ovipositing. Only insects emerging in December and early January could find host plants. In the case of farming under irrigation, the awakening flies in November find plenty of host plants; most of the flies lay eggs, thus giving rise to a strong generation to further attack the onion fields.

The period of a single stand of a crop may also be prolonged by irrigation as long as the temperature permits. Cotton, when grown without irrigation in Israel, is harvested during August; under irrigation, this crop in the same locality is harvested during September and October. In the Beit Shean Valley (near the Jordan River) the vegetative period of the stand is extended until November. Here this prolongation is essential, because in the too warm days of July and early August there is a general blossom drop, which ceases in the middle of August; the prolongation allows the fruiting of the late blossoms to make up for the loss.

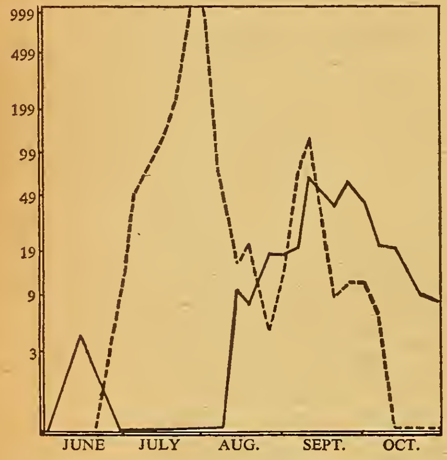
These prolongations accentuate the infestations by the spiny bollworm *Earias insulana* and the Egyptian cotton leafworm *Spodoptera littoralis.* As diagramed on the next page, the cotton leafworm, whose population climaxes in July, may raise one additional generation in September, and if fresh food is available in the Beit Shean Valley, another in October. The population of the spiny bollworm is at a very low level during July and early August, but begins to rise in the second half of August. Dry-farmed cotton may escape the attack of the renewed wave of pests, since the bolls have dried and are ready for harvest. However, in irrigated fields, the period from August to October is the most crucial as far as the attack of *Earias* is concerned.

Changes in Physiological State of Host Plants

In Israel, the population of aphids reaches its peak in March. A sharp decline in the number of species and individuals takes place toward the end of April (Bodenheimer, 1940), but some species are also active during the summer. In a study of the aphids occurring on fruit trees in Israel, Swirski (1954) found that *Aphis pomi* remained on irrigated apple trees a longer period and were more numerous than on non-irrigated trees, and that *Aphis punicae* was more abundant on irrigated pomegranates than on non-irrigated trees.

The reason for this is that irrigated trees continue to produce new growth, and young leaves are available throughout the summer. That young leaves are attacked by aphids more than mature ones was pointed out by Kennedy *et al.,* (1950) who noticed that young and senescent sugar beet leaves were more infested with *Aphis fabae* than mature leaves.

Sokolov and Sokolov (1952) found that young leaves of apples are more attacked by *Aphis pomi* than are mature leaves and that their infestation varied inversely with the osmotic pressure. Harpaz' (1953) explanation was that during the arid spring, when the osmotic pressure of the cell sap is greater than that of the aphid secretion injected into the spaces in cell tissue, the cell sap does not permeate through the cell walls and the insect can not obtain it. Another theory advanced by Kessler *et al.*, (1959) is that the soluble nitrogen is greater in young and senescent leaves than it is in mature ones, and the proportion of RNA to DNA is smaller in young, than in mature, leaves. These qualities, the authors claim, may be responsible for the increased infestation by aphids in young leaves.



Population fluctuations of Spodoptera littoralis (*broken line*) *and* Earias insulana *from a sixty-plant sample in an irrigated cotton field.*

Irrigation-Induced Changes in Microclimates

The seed-corn maggot, which is cogeneric to the onion fly, differs from it in being polyphagous. Yathom (1961) who studied this fly in Israel, states that until the early fifties this fly was hardly felt as a pest, although it did exist in Israel. Bodenheimer (1930) mentions it as a predator of locust eggs, and its first discovery as a seed pest in 1935 was recorded much later, in a publication called *Rare Pests of Truck Crops* (Schweig, 1951). Today preventive measures must be taken against it when sowing cucurbits, peanuts, beans, cotton, or corn, in order to avoid the necessity of reseeding. In discussing the factors that have changed the status of this fly from an unknown insect to a pest of primary importance, Yathom states that irrigated fields or those that have been recently ploughed attract flies for oviposition. This author demonstrated how hardly any females of this species laid eggs on dry soil, whereas hundreds of eggs were laid on moist soil by the same number of females.

In dry farming the growing of summer crops is based on exploiting the moisture that has accumulated in the ground from winter rains. Later, some crops are watered in their furrows. Such conditions do not encourage egg laying or the development of the pest species, as is the case in agricultural practices today where the field is seeded and then irrigated. In this latter method, crops are strongly attacked by the seed-corn maggot; whereas in dry farming, crops are hardly infested, and although the soil remains moist enough to cause germination of the beans, the surface becomes too dry to attract the ovipositing flies.

In our effort to explain how the population of the seed-corn maggot *Hylemyia cilicrura* increased in Israel, we should consider the chances, in April, of synchronization of the presence of many gravid adults with ecologically favorable conditions for oviposition—namely, irrigated fields. Such fields were not available in dry farming when sesame, sorghum, and melons were sown in moist soil without subsequent irrigation. Such fields are plentiful today when large areas of peanuts, cotton, corn, and other crops are sown and later watered by overhead systems.

Another example of the effect of microclimatic change is provided by the red pumpkin beetle, *Rhaphidopalpa foveicollis.* On emergence from diapause, these beetles feed on the leaves of the young cucurbit seedlings. When numerous, they may inflict severe damage necessitating reseeding of entire fields. However, the more important injury is caused by the larvae, which feed upon, and bore into, the roots. Bacterial rot develops, and the plant succumbs suddenly; entire fields may thus be destroyed. The loss is aggravated because this damage often happens only a week or two before the fruit is to be picked for marketing. Injury of a third type is caused by the larvae when they emerge to the surface and feed upon the nearly mature fruit. In recent years, the situation caused by this pest has become quite serious due to the change from furrow to overhead irrigation.

The eggs of *Rhaphidopalpa foveicollis* need contact moisture for development (Melamed, 1960). Eggs deposited near plants growing under ditch irrigation may not have the necessary moisture, so many eggs perish. In the case of overhead irrigation, the entire area is uniformly watered, offering ideal conditions for the eggs to hatch. The larvae enter the soil and feed upon the roots, penetrating the main root as they grow larger.

Unlike the eggs, mature larvae are susceptible to excessive moisture. When the field becomes saturated with water supplied by the sprinklers, the mature larvae leave the soil and seek shelter under the fruit, which they also eat. In fields irrigated in furrows, this does not happen, and in fields where overhead irrigation is not too copious the infestation may be limited to the lower areas of the field where moisture is accumulated.

Summary

When land is irrigated in an arid zone, an enclave of a different biocenosis, an oasis, is created. Insects typical to this biocenosis and to the plants grown there will invade it. This invasion may be by drift as with the aphids; by dispersal as happened with *Earias* in the Negev; or by migration as with *Agrotis ypsilon*. It is quite natural that larger and more numerous fields of a certain crop will provide larger quantities of food for the insects that depend upon this crop, and that larger populations of these insects will develop; this is what happened with *Spodoptera littoralis* in Israel.

The prolongation of the vegetative period of a certain crop by repeated sowings will increase the insects depending upon it, provided biological habits permit it. This happened in Israel with *Chilo agamemnon* in corn, *Atherigona varia soccata* in sorghum, and *Baris grannulipennis* in cucurbits.

In certain plants irrigation may cause changes in the composition of the cell sap. Such changes may cause the increase of aphids and prolong their activity period; such changes may also divert the diapause period in sucking insects such as the black scale, *Saissetia oleae*.

In Israel the advantages of overhead sprinkling are: (1) saving expensive labor, (2) the possibility of employing labor unskilled in agriculture, and (3) the possibility of irrigating areas and slopes where furrow irrigation is impossible or difficult.

However, there are also some disadvantages to this kind of irrigation. In a comparative study between overhead sprinkling and furrow-irrigated plots in Israel, it was found that overhead-sprinkled tomatoes yielded less fruit than furrow-irrigated plots. Often the yield was one-third to one-half less than the yield in the furrow-irrigated plots.

Also, some diseases develop more frequently in overhead-sprinkled plots. It has been pointed out that overhead sprinkling over the stand creates a microclimate that favors development of diseases. According to Rotem *et al.*, (1966) the change of the microclimate consists of a higher relative humidity, 30 to 40 per cent above that of the surroundings, and the lowering of temperature by 2° to 8°C. However, this occurs only during the sprinkling period and for an hour or two afterward, and then only on extremely warm and dry days or dry, but windless, nights. Only organisms associated with excessive moisture, such as the fungus *Stemphylum botryosparius* f. *lycopersici*, can develop under the conditions created by sprinkling. Others develop better in furrow-irrigated plots (Rotem *et al.*, 1966). As to differences regarding insect infestations, it has been claimed that sprinkled plots were slightly more infested with *Spodoptera* eggs than furrow-irrigated plots. Possibly the changes in the microclimate of the stand are of too short duration and at too long intervals to allow drastic changes in insect populations.

The situation is different with the changes in microclimatic conditions created in the soil. Overhead sprinkling covers the entire surface of the soil, and the changes are of longer duration. Insects that need contact moisture for development will thrive better in overhead-sprinkled soil, as happens with the eggs of the red pumpkin bettle. Insects that cannot stand too much moisture will leave the soil as did the larvae of that pest. The moisture over the soil, as a result of overhead sprinkling, will attract moisture-loving insects like the seed-corn maggot *Hylemyia cilicrura* in greater numbers, and the development of the eggs and larvae will be more successful.

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SCHISTOSOMIASIS The Disease

The problem of pest outbreaks is not the only one that can be anticipated in the costly public works projects designed to irrigate tropical lands. Perhaps the most dramatic and formidable of the impediments to the promised well-being of the people affected by these large-scale projects is the spread of debilitating disease in the wake of the coming of perennial irrigation. Chief among these is bilharziasis (also known as schistosomiasis or blood fluke). Here is a largely man-made plague that can defeat the best attempts at technological development in the impoverished nations of Africa, Asia, and South America. Upon the replacement of age-old, simple techniques of irrigation in Egypt, for example, snails in increasing numbers invaded the quiet, slow, warm waters now available in the secondary and tertiary canals and ditches that bring irrigation water to the fields. Certain species of snails are the secondary hosts of schistosomes, parasitic worms causing bilharziasis. There is very close correlation between the endemic areas of this disease and the areas now under perennial irrigation. Before the establishment of such projects, irrigation was largely seasonal and basin type (where floodwaters were collected in basins and gradually used in the growing season following the floods). Here, any invasion of snail populations was necessarily largely seasonal and short-lived. Now there is an increase in the extent of the habitat favorable to snails throughout a large part of the year. Available figures show that upon the establishment of perennial irrigation schemes dependent on a permanent supply of water, the incidence of this disease increases tremendously, usually from just a few per cent to well over one half of the population, sometimes even approaching 100 per cent.

In an infected person the disease usually takes one of two forms: urinary (or bladder) schistosomiasis, which is caused by the helminth (parasitic worm) Schistosoma haematobium, *and intestinal schistosomiasis, which is chiefly due to* S. mansoni. *In the former, the worms lay eggs near the ends of blood vessels surrounding the bladder; these eggs then begin to penetrate the bladder wall. If they are successful, they will be discharged in the urine; if not, they will be trapped in the wall of the bladder, giving rise to further complications. On contact with water, they hatch, producing free-swimming forms*

Control in Egypt and the Sudan

by Henry van der Schalie

The World Health Organization program called Egypt 10, designed to carry out four phases of bilharziasis control in one area (the Qalyub tract), determined that, of the 32,000 people living in the six villages of the 5,000-acre tract, at least half the population in most of the villages was infected with the disease. The following programs were instituted: (1) a sanitation program designed to provide potable water by building 150 wells and pumps and 5,000 borehole latrines to prevent eggs of the schistosomes from getting to the canals and drains; (2) a medical program by the government, in which patients found to be positive were given Fouadin intramuscularly (70,000 shots were given); (3) a program of health education to apprise the people of the nature of the disease and what they would need to do to prevent infection; (4) a snail control program, following the principle that a preventive campaign would constitute the best possible defense. This last phase of the program involves some of the ecological consequences and reveals the difficulty of obtaining better co-ordination and co-operation.

A direct correlation exists between the kind of irrigation practiced by people in endemic areas of bilharziasis and the incidence of human blood fluke. The delta, with its extensive perennial irrigation, has a fabulously high incidence of both *Schistosoma mansoni* and *S. haematobium*, while the Nile above Cairo, with basin irrigation, shows very spotty and low incidence of *S. mansoni* (imported from the delta) and *S. haematobium* was estimated at only 5 per cent. The change now projected for the Upper Nile, when the new High Dam is completed, warrants some real concern; therefore, I sought funds two years ago to study the possibility that the new dam might well prove to be a liability rather than an asset; but these plans were ended by the war. It is quite certain that the incidence of urinary schistoso-

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ved-Down Waters

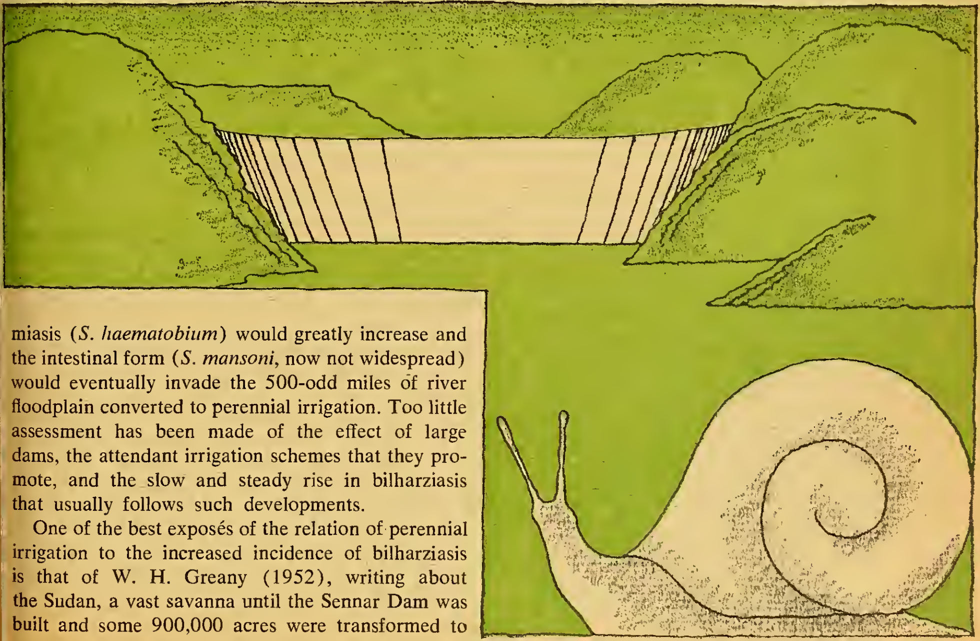
known as miracidia, which then set about finding a suitable snail species that will harbor them for the next major period of their lives. They enter the snail's body where they undergo a complex series of changes and further multiplication. They eventually emerge as a free-swimming form called cercariae, now in search of human and other animal hosts. To enter the body they penetrate the skin of a host who has had contact with infested water. If such water is swallowed, cercariae can penetrate the gastric tract. In either case, they reach the liver, where they grow and mate. Now they are ready to enter the bloodstream and make their way to the plexus of the bladder, completing the transmission cycle.

In the case of S. mansoni, *the life history is similar, except that the host snail species differs, the adult worms inhabit the mesenteric plexus, and the transmission to snails occurs via the feces instead of the urine.*

In the urinary form of the disease, haematuria (blood in the urine) is usually present. There is now some evidence that the disease may be a cause of cancer of the bladder; thus, some mortality ascribed to the latter may in fact be due to the former.

By far the more serious form is the intestinal. Dr. Shiff reports some fatality due to liver and spleen enlargement. Unfortunately, the spread of modern agricultural practices that depend on stabilizing the water resources (i. e., dam building and irrigation) carries the heavy price of the health of most of the very population it is supposed to benefit. Dr. Shiff reviews the situation in Rhodesia where not only an increase in the quantity but also an ominous increase in severity of infection is reported. Stabilized water favors the host snails of S. mansoni. *In addition, in extending the range of habitat of the snails and providing more stable breeding grounds, the chances of constant reinfection are increased, resulting in a heavier worm load per infected individual.*

The tremendous, continuing increase in the incidence of bilharziasis is one more manifestation of a biological dilemma: the basic vulnerability of an artificial ecosystem. Disease and suffering for millions of people are a direct outcome of the attempt to control the processes of nature with the simplistic solutions that modern technology offers in the form of simple, managed ecosystems in place of the intrinsically complex natural systems.



miasis (*S. haematobium*) would greatly increase and the intestinal form (*S. mansoni*, now not widespread) would eventually invade the 500-odd miles of river floodplain converted to perennial irrigation. Too little assessment has been made of the effect of large dams, the attendant irrigation schemes that they promote, and the slow and steady rise in bilharziasis that usually follows such developments.

One of the best exposés of the relation of perennial irrigation to the increased incidence of bilharziasis is that of W. H. Greany (1952), writing about the Sudan, a vast savanna until the Sennar Dam was built and some 900,000 acres were transformed to form the Gezira Irrigated Area. This is a large agricultural scheme whose irrigation system runs parallel to the Blue Nile south of Khartoum. Three years after irrigation was introduced, both *S. mansoni* and *S. haematobium* were well established and on the ascendancy among the population. If one compares the Sudan with conditions in Egypt, one finds some very basic similarities in the two regions: (1) the people are mainly Islamic and practice the rites of their religion (ablutions, *wadu*, or washing before prayers); (2) they often use canal water for bathing, washing clothes, and tending the *gamoosa* (water buffalo), which youngsters almost daily take into the canals; and (3) they work in the fields in similar irrigation systems designed to grow cotton and other staple crops. However, in several ways the areas are strikingly different, giving more hope for protecting the health of the people in the Sudan than in Egypt. The Sudanese have room to build homes and sanitary facilities; they enjoy a higher standard of living, and with the comparatively lower incidence of bilharziasis are more vigorous in coming to grips with their problems.

Egypt, over hundreds of years, has become unbelievably infested with bilharziasis. Health conditions in rural Egypt were documented in the delta region by John Weir and his associates in 1952 at Sindbis, near the Qalyub Egypt 10 tract. They provided the first meaningful mortality and morbidity data and showed that the life expectancy of women in that region was 27 years and that of men was 25. In Egypt the countryside of the delta is virtually rotten with the disease. The overpopulated area with its farm population in horribly crowded villages, the lack of sanitation and the near impossibility of building proper facilities for potable water and waste disposal, the many unfortunate daily practices that allow for an amazing exposure to infection—all contribute to make the conditions in the areas where perennial irrigation exists almost impossible to control. The amazing ramifications, as they relate to politics, economics, education, agricultural practices, etc., compound the problems.

The Sudan in many ways typifies the emergent countries of Africa where bilharziasis remains at a low ebb until irrigation is developed, after which snail hosts and aquatic vegetation flourish. Migrant laborers carrying the infection move into the area, and the habits of the people encourage a steady rise in the incidence of bilharziasis. The problem of control in the Sudan is also serious and difficult, but the area lends itself much better to control work than Egypt, and prospects look brighter. In the Sudan there is room not only for people to live but also to provide such sanitary facilities as wells and latrines. However, while roughly a million acres are now cultivated, the area between the White and the Blue Nile will allow for the development of two million more acres, thus increasing the chances of the spread of bilharziasis. Since the disease has not spread so widely as it has in the Lower Nile or delta of Egypt, the Sudanese may be more vigorous with a more healthy attitude toward initiating constructive reforms. Key aspects such as education, medication, sanitation, and potential snail control seem to be kept more in focus where support for collateral and integrated activity is needed.

The various findings of Egypt 10 regarding these facets of the problem are instructive. In an Egyptian village it is almost impossible to provide sanitary facilities. Borehole latrines were installed under Egypt 10, but soon became open cesspools because the water table was so high. People were obviously not able to cope with them even in the few houses where they could be properly installed. Few seemed to realize that those latrines can serve only about nine months; it was well-nigh impossible to re-establish latrines once they had filled up, and they became frightfully putrid in high summer temperatures. Unfortunately, it is precisely under the hot summer conditions that it is essential to provide the population with indoor latrines. Co-ordination between the several aspects of the project failed; the program could probably have profited from assistance available in parallel programs such as are now sponsored by AID.

Health education undoubtedly serves as one of the best ways to inform the people of the endemic area about the nature of the disease. In the Sudan, in 1954, there were some excellent village councils of people active in their communities. The paucity of leaders available in the Egyptian villages—usually only the mayor, the imam (the religious leader), the school teacher, and an occasional person from another profession—made work in the community very difficult. Yet, the adults and the children were aware of the program and whatever means were available were mustered for the benefit of the protective aspects of the work.

In terms of the medical aspects, the control of bilharziasis is proving very difficult, although many drug houses have been working for a number of years to find a suitable drug. Most drugs currently in use have serious side effects, including possible death. Attaining a cure is often questionable, because the disease is so debilitating. Two major obstacles appear in the medical approach to control: (1) The eggs, in failing to find their way out of the body, cause serious pathological changes in the liver, spleen, colon, and other organs; thus drugs are of little help in advanced cases; and (2) in endemic regions poverty is so great that few can obtain medication unless the government provides such help. The government program is too onerous an experience, usually amounting to a loss of twenty whole days in a month. While the programs are usually administered by medical personnel, the first line of defense obviously is not within that field.

In the last analysis, snail control seems to offer some hope for reducing the incidence of the disease. The actual number of snails infected in nature is surprisingly low. In the Egypt 10 project, the highest rate of infection among the *S. haematobium* snails brought in from the fields was 0.3 per cent! This low incidence appeared in more than 14,000 snails collected from many stations in the 5,000-acre tract. Yet, the incidence among humans in the six villages ran over 50 per cent for most of them and that in Barada was at least 70 per cent. Evidently, sometime after the middle of May a few infected snails, widely scattered (not necessarily near the villages), produce enough cercariae to almost saturate the population because of the amount of contact people in the countryside have with infested water.

It is important to note that most snails in Egypt lose their infections in the winter, and it has been brought home all too well in our Ann Arbor laboratory that chilling snails in the aquariums, come the fall of the year, cancels out the infections. In a recent WHO report (1965), a paper by C. H. Barlow (1939) stated: "For 5 years the writer and his men have worked barehanded in the El Marg area during January, February and March without becoming infected. Constant crushing and dissecting of snails have presented a picture of such inactivity of whatever cercariae exist that an assumption of security seems warranted." In two consecutive years of observations, for which there are good data, the team in Egypt 10 found that there were practically no snails shedding infectious cercariae until the middle of May! This observation obviously has great significance in all planning in epidemiology. Yet, in an excellent series of reports by the teams in Egypt 49 there is virtually no mention of this very important functional relationship in the epidemiology of this disease.

To summarize, bilharziasis poses a very serious problem in both Egypt and the Sudan. Integrated programs are needed if any hope for its control is to be justified. Few diseases demand more collaboration in more fields and at every level. International programs too often fail to make their programs mesh with bilharziasis control, and within the infected country the scourge of this disease enters practically every field of human endeavor. Programs within an agency such as WHO concentrate on the immediate aspects (usually medicine, sanitation, education, and snail control), but many other important fields must also be involved. It is clear that the *perennial* system of irrigation is most explosive in producing a high incidence of bilharziasis, a fact well exemplified in the Sudan. Problems become difficult because in primitive conditions all facets of living have their own special relation to the control problem. In brief, the need for integration and planning seems overwhelming, but the prospects for obtaining relief are dim. In the meantime, the emerging countries in Africa face frightening increases in the incidence of bilharziasis.

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Host and Parasite in Rhodesia

by C. J. Shiff

It is reasonable to presume that the schistosomes have been parasites of man for some considerable part of his evolutionary history. Under the ecological conditions that prevailed in the past, the interrelationship between both primary and secondary hosts and the parasite itself had evolved toward an equilibrium; thus the schistosomes were in a position to maintain their numbers among the sparse and nomadic populations of man and the temporary and rather unstable populations of aquatic snails, without causing excessive stress on the infected persons.

This pattern of host-parasite relationship probably existed in Rhodesia until rapid economic and agricultural development resulted in settlement and massive increase of the human population. Recently, soil and water conservation procedures in that country have produced major changes in the over-all hydrological picture. The construction of dams has stabilized water flow and resulted in fewer flash

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floods in the streams and rivers. Thus, there has been an increase in the extent of the snail habitat throughout the country. Because the water bodies are more durable, aquatic snail populations can increase as a result of the general amelioration of the environment.

Where agricultural projects are based on irrigation, large populations now live in close relationship with stable water systems; snails invade and breed, water contact and pollution increase, and these, in turn, produce a major upsurge in the prevalence of bilharziasis and, what is probably more serious, increases the worm load of infected persons.

The Aquatic Environment and Schistosome Transmission

An association between the level of schistosome transmission and the geographical extent of surface water was noticed as early as 1915, when Orpen (1915) recorded a 31 per cent infection among 592 prisoners, the majority of those infected coming from the northern, damper parts of the country. This pattern was strikingly demonstrated more recently by Clarke (1966) who analyzed the age prevalence of both *Schistosoma haematobium* and *S. mansoni* in several different communities in Rhodesia. In Table 1 the association between climate, topography, extent of water availability, and prevalence of the parasite (*S. haematobium*) are clearly shown. In particular, the high prevalence seen in an established irrigation scheme some 40 years old (Table 1, No. 5) in the hot lowveld, approximately 2,000 feet above sea level, shows the degree of transmission that can develop. Under these conditions there is not the appreciable decrease in prevalence among the older age groups that characterizes all other populations surveyed, even the newly established irrigation scheme (Table 1).

The pattern of transmission seen in Table 1 is further accentuated in Table 2, which deals with the prevalence of *S. mansoni* in the same localities. Where water bodies are inclined to be unstable and temporary, as with communities 3 and 4, the parasite is rare. It becomes more common in communities associated with stable water bodies, especially where temperature and contact increase. Again the prevalence in community 5 shows a particularly high rate of transmission.

The close association between *S. mansoni* and the communities living close to stable water systems is a direct result of the ecology of *Biomphalaria pfeifferi*, the intermediate host snail involved in the transmission cycle. The response of a species to a set of environmental conditions can be measured by rearing individuals under those particular conditions and calculating from the age-specific birth and death rates the parameter *r*, the intrinsic rate of natural increase. It can be inferred from these data that *B. pfeifferi* is better adapted to existence under the stable, well-buffered temperature conditions normally found in large water bodies. *Bulinus globosus* another intermediate host snail, on the contrary, shows the characteristic adaptation to temporary habitats. It can breed rapidly during relatively short periods when conditions are ideal, and thus build up sufficient numbers to survive ensuing catas-

TABLE 1. Prevalence of *Schistosoma haematobium* infections in several communities in Rhodesia. After Clarke (1966).

COMMUNITY NUMBER	OCCUPATION	ALTITUDE	HYDROLOGY		AGE GROUPS							
					UNDER 4	4-6	7-9	10-12	13-15	16-20	21-40	OVER 40
1.	rural mine-workers	middleveld[A] 2-4000′	well watered perennial[B]	No. examined	25	49	58	46	26	15	68	41
				% +ve	16	61	78	80	88	80	24	5
2.	rural mine-workers	highveld over 4000′	well watered seasonal[B]	No. examined	32	62	74	54	52	33	45	52
				% +ve	3	16	34	63	69	52	29	8
3.	rural mine-workers	middleveld 2-4000′	well watered seasonal	No. examined	18	40	66	106	77	78	22	20
				% +ve	6	20	33	57	53	44	18	10
4.	rural mine-workers	highveld over 4000′	poorly watered seasonal	No. examined	18	25	100	76	13	15	114	102
				% +ve	Nil	12	13	13	39	29	13	1
5.	irrigation (old)	lowveld under 2000′	well watered perennial	No. examined	9	76	55	25	13	21	101	35
				% +ve	89	96	98	96	92	90	72	57
6.	irrigation (new)	lowveld under 2000′	well watered perennial	No. examined	30	87	66	38	42	106	237	116
				% +ve	30	30	54	74	67	55	33	7

[A] As Rhodesia is a tropical country prevailing temperatures increase as altitude decreases.

[B] The distinction between perennial and seasonal is based on availability of water from permanent sources or temporary ponds filled by seasonal rains.

TABLE 2. Prevalence of *Schistosoma mansoni* infections in Rhodesia. Surveys made in the same communities as in Table 1 and at the same time. After Clarke (1966).

COMMUNITY NUMBER		AGE GROUPS							
		UNDER 4	4-6	7-9	10-12	13-15	16-20	21-40	OVER 40
1.	No. examined	6	27	45	50	24	Not done	29	11
	% +ve	Nil	41	78	58	58		38	18
2.	No. examined	33	61	73	53	52	33	106	51
	% +ve	3	7	10	43	44	18	15	20
3.	No. examined	20	37	60	84	67	59	21	20
	% +ve	5	3	5	6	3	12	14	5
4.	No. examined	14	26	100	75	14	9	95	95
	% +ve	Nil	Nil	5	3	Nil	Nil	6	6
5.	No. examined	8	70	51	23	15	24	95	32
	% +ve	50	83	92	87	67	50	59	50
6.	No. examined	30	87	66	38	42	106	237	116
	% +ve	13	11	17	50	24	16	10	7

trophes such as flooding or desiccation, both features of the season pattern in this latter biotope.

The impact of development in rural Africa has produced an illness of increasing severity. Increasing *S. haematobium* infections, with concomitant kidney and bladder damage, are slowly being superseded in the population by an increase in the even more dangerous parasite, *S. mansoni*, as populations of *B. pfeifferi* flourish in the now stable water bodies being introduced throughout the country. The difference between temporary and stable habitats shows in differential effects on humans. White school children from rural areas are inclined to swim and fish in farm dams, while their counterparts, the black school children, have more contact with river water in the rural areas. In a recent survey of 490 white children in Victoria Province, the ratio of *mansoni* to *haematobium* was 3:1. In Bantu children from the same province the *mansoni* to *haematobium* ratio was 1:9.6.

A recent survey among the population of a small irrigation scheme in the Zambesi Valley (hot, lowveld) indicated that, of 193 people examined, 89 per cent were infected with *S. mansoni* while only 20 per cent showed signs of *S. haematobium.* Prior to the survey eleven deaths had occurred among children between 5 and 13 years of age and a further 16 children, all exhibiting similar symptoms of hepatosplenomegaly, were given treatment for *S. mansoni.*

As can be expected, with the more intense cycle of infection, people are now carrying increasingly heavier burdens of the adult schistosome worms. As a result of this an increased number of unusual symptoms and sequelae of bilharziasis are being noticed. Bird (1965), in reporting on cases of spinal complications in bilharziasis, mentions that until 1963 the literature reported a total of 26 cases of *S. mansoni* and 11 of *S. haematobium* with these ramifications. In 1964, Bird himself experienced a total of eight such cases, one of which was terminal. Later, Zilberg (1967) noted a case of *S. mansoni*-induced paraplegia in a child, while cerebral abnormalities were seen in three other cases (Zilberg *et al.*, 1967). A further seven undocumented cases of paraplegia, presumed to be of bilharzial origin, were reported to the Rhodesian Ministry of Health in 1967. This indicated that in the last four years almost as many cases of spinal complications due to schistosomes have been reported in southern Africa alone as were reported for the whole globe up to 1963 (excluding *S. japonicum* infections).

Future Outlook

With the rapid increase in population in central and southern Africa, development of agriculture will depend more and more on irrigation, especially in the drier parts of the country where rainfall is unreliable. In Rhodesia, from 1964 until recently, the amount of irrigated land has increased by nearly 100,000 acres. There are now 126 irrigation schemes ranging in area from 20 to 3,000 acres in rural areas reserved for Bantu settlement. These derive water from dams of various sizes, perennial rivers, or from subterranean sources. However, regardless of the source of water, the aquatic biotope is stabilizing, a process carrying with it the certain spread and intensification of this crippling disease.

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KARIBA DAM

Professor Scudder has spent many years studying the ecological consequences of major water development projects in Africa. In a previous work, he documented the problems of relocation brought upon the Nubians of the Nile Valley. After trying for a long time to cope with the conditions created by the earlier Aswan Lake in 1933, the Nubian farmers found the fluctuation in the water flow so unpredictable, due to constant manipulation by the hydroelectric engineers, that the majority had to abandon farming, their traditional means of subsistence. After describing the serious changes induced by the Kariba Dam, between Zambia and Rhodesia, Professor Scudder reflects upon the possibility that here, too, the cultivation of floodplain alluviums by the Zambians may have to be abandoned.

The Kariba Dam was the first of the major African impoundments. With a storage capacity of approximately 130 million acre-feet and a surface area of over 1,700 square miles, Lake Kariba became the largest man-made lake in the world when it filled to capacity in mid-1963.

Looking to the future, one can foresee that all the major rivers of Africa, Asia, and Latin America will be dammed, along with many of the lesser ones. The construction of Kariba started a trend that will

The Ecological Hazards of Making a Lake

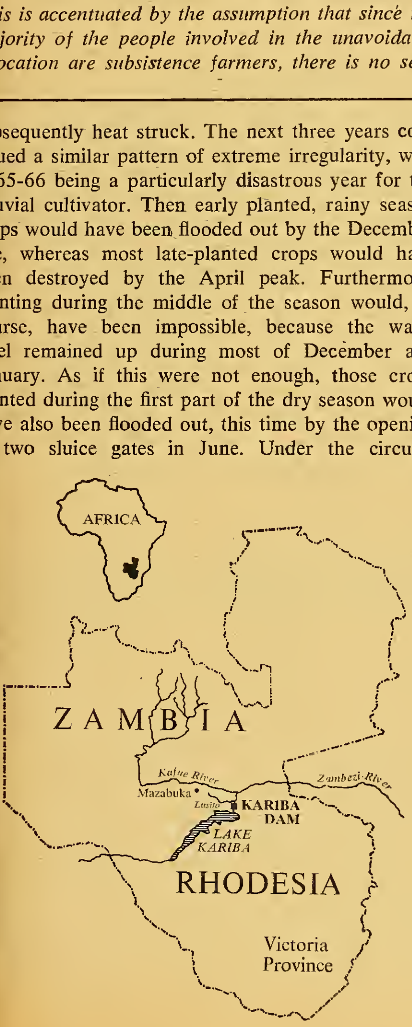
by Thayer Scudder

The impact of the Kariba Dam on alluvial cultivation below the damsite is an example of how man's engineering capacities can drastically reduce the productivity of an existing ecosystem. A glance at figures 1 and 2 is sufficient to show the extreme irregularity that has been introduced into the annual regime of the Zambezi River between Kariba gorge and the Kafue River as a result of the dam. Although commercial agriculture is of virtually no importance at present in the stretch of river involved, this is of little comfort to those thousands of Africans who desire to cultivate the fertile alluviums on a twice annual basis for their own subsistence. Here we have a pattern of increased risks for the farmer in an already high-risk environment. It is too early to predict how the farmer will respond, although it is already obvious that he has suffered far more loss from man's manipulation of the Zambezi than he ever did during any equivalent time period in the past.

For the first three years (October, 1958–September, 1961), there was no Zambezi flood between the dam and the Kafue confluence; indeed, no water was released in the first seven months that the dam was sealed, except for a small trickle in March/April, 1959. During the rainy season, the agricultural implications of having the Zambezi restricted to its primary channel throughout this period were inconsequential for alluvium previously cultivated. On the other hand, the area that could be cultivated during the dry season was greatly reduced because of the absence of annual flooding. During the 1961-62 season, the dam-controlled regime approximated the original flow pattern for the first time since impoundment began. While this must have been a relief to those farmers who had suffered during the previous three dry seasons, it proved disastrous for those who had begun to cultivate rainy season gardens on the lower-level alluviums. This land had never been cultivated during the rains in the past because of flooding during the annual rise of the Zambezi. When this pattern was approximated in April, 1962, through nearly a sixfold increase in river flow over the previous month, these new gardens were inundated by over ten feet of water within a single day. (According to the District Assistant for Lusitu, this loss of crops subsequently led to a food shortage in the Lusitu village of Kadabuka, which was most dependent on the gardens concerned.) The next year the man-made flood of the Zambezi came in February, again destroying crops in these lower-terrace alluvial gardens, but fortunately not rising sufficiently high so as to destroy the extensive maize gardens planted in the Lusitu Delta.

The case was altogether different, however, during 1963-64. Then three sluice gates were alternately opened and shut throughout most of the rains, so that virtually none of the Zambezi and tributary delta alluviums could even be planted during the most important agricultural season. Furthermore, since the river dropped rapidly in March, and no rain fell during April, dry-season crops planted at that time on the higher alluviums would have been *no doubt alter the African landscape and affect the lives of millions of people. In an undertaking as large as the creation of these huge bodies of water and the ensuing manipulation of the water flow in the rivers, it is natural to expect serious consequences. Since the construction of these dams is usually undertaken for a single purpose—the creation of large amounts of electricity for use in emerging urban-industrial complexes—the effects on agriculture are considered of secondary importance. This is accentuated by the assumption that since the majority of the people involved in the unavoidable relocation are subsistence farmers, there is no serious harm done insofar as the gross national product (GNP) is concerned, if these people end up being forced away from the land. However, the serious fallacy in this assumption is clear from the following paper. The products of subsistence farming never enter the economists' GNP equations because there is no income: the products are consumed locally. But when these crops fail and there is a famine, the central governments can count on a heavy burden, provided that relief programs can be organized to reach the hinterlands. Hence it is fallacious to claim that subsistence output contributes nothing to the national wealth.*

subsequently heat struck. The next three years continued a similar pattern of extreme irregularity, with 1965-66 being a particularly disastrous year for the alluvial cultivator. Then early planted, rainy season crops would have been flooded out by the December rise, whereas most late-planted crops would have been destroyed by the April peak. Furthermore, planting during the middle of the season would, of course, have been impossible, because the water level remained up during most of December and January. As if this were not enough, those crops planted during the first part of the dry season would have also been flooded out, this time by the opening of two sluice gates in June. Under the circumstances, it is hard to imagine how those regulating the flow of water through the dam could have acted in a way more detrimental to downriver agriculture.



At this point it is important to emphasize, in all fairness, that Zambian population densities in the downriver area are low except in the Lusitu area where relocation was responsible for creating one of the highest rural densities in the country. Furthermore, practically all of the food grown on riverine alluviums is for local consumption. On the other hand, I am not aware that those planning for Kariba even considered the implications of alternate outflows for the future development of the downriver area. Nor am I aware that they considered the costs of possible food shortages arising from the present regime for the local people and for the government. I am protesting not so much against what happened as against the narrow viewpoint of those responsible for planning installations like Kariba. This project was essentially a unipurpose scheme. The population to be relocated was seen, not as a resource, but as an expensive nuisance, whose very existence was unfortunate. As for the future lake, it was strictly a by-product of the dam, whereas the needs of downriver inhabitants were considered only where backed up by political power, and then were seen as constraints by those who viewed the Kariba Project almost entirely as a means for generating power.

My study of a single Tonga village in 1956-57 showed that the large majority of farms in the

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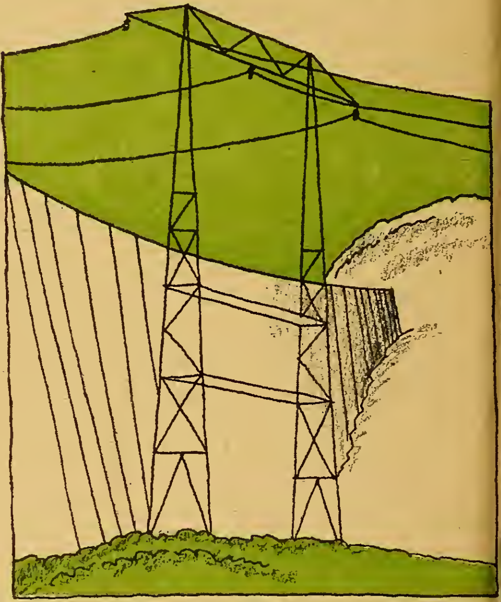
Middle Zambezi Valley cultivated roughly one acre per capita, the expected harvest being sufficient to support the population during most years (Scudder, 1962). Unfortunately, just prior to relocation, the valley did not provide this minimum, in large part because of population increase and land degradation. (As used in this paper, land degradation includes both sheet and gully erosion and reduced fertility arising from overcultivation and overgrazing with or without accompanying erosion.) Though the annually inundated alluvial soils could support permanent cultivation for an indefinite period, over 20 per cent of the farmers in our five river villages did not have any access to such lands. Furthermore, of those who did, only a small proportion controlled large enough acreages to meet their consumption needs. In other words, most of the population also relied on the cultivation of less fertile, upper-level alluviums and on colluvial and karroo soils, which had to be periodically fallowed. Though the Tonga were quite familiar with the amount of fallowing that their various garden types required to restore fertility, lack of additional land was responsible for the overcultivation and hence exhaustion of certain alluvial gardens by the 1930's. This process continued during the 1940's, when certain farmers began to pioneer less fertile karroo soils well back in the bush. By 1957, most of the better karroo soils within walking distance were under cultivation, while extensive areas of upper-terrace alluvium were so degraded as to be under indefinite fallow. Although the situation would have continued to deteriorate, since the exhaustion of the karroo soils was only a matter of years away, relocation intervened. The overtaxed lands were flooded, and the people were moved toward the valley's outer margin or into the Lusitu area below the damsite.

Resettlement, however, did not solve the land problem. In fact, for many villages in the southern portion of the valley, it only made it worse; since those soils least susceptible to degradation through cultivation had been permanently flooded along the banks of the Zambezi and the lower reaches of the major tributaries. Table I shows the amount of land available for relocation within the valley. Under the local system of agriculture, less than 40 per cent of this land could support semipermanent cultivation (category 1),[1] which involves five to ten years of continuous cropping, followed by a fallow period of approximately equal length. The rest (category 2), ranging in quality from fair to poor, could support, at best, cultivation for about six years, followed by a twenty-year fallow. With almost all of the arable land in the valley surveyed, this meant that semipermanent cultivators needed an absolute minimum of two acres per capita, whereas bush fallow cultivators needed five or more. The situation was by far the worst in Mwemba, where 9,000 people had access to approximately 20,000 acres of category 2 soil, much of which fell in the less fertile and more easily erosible grades. To meet their needs, at least 40,000 more acres were needed.

The problem of land shortage presented by relocation was obvious from the start to all government officials concerned. After resettlement had been completed, it was known that approximately one-third of the population would find themselves in serious straits within ten years. The rest were more fortunate, although there was little room for population increase in some areas, and all areas could easily become degraded in the years ahead through erosion, overcultivation, and overgrazing.



The Department of Agriculture's response to this situation was to emphasize erosion control and agricultural intensification, although there was general agreement that the situation in the south of Mwemba was hopeless without further relocation. Two types of erosion control were stressed. The first would involve a prohibition of cultivation within 25 ards of the banks of major tributaries. The need for uch an ordinance was obvious to all ecologically oriented personnel familiar with the tributary system on the plateau, in the escarpment, and in the valley. Referring to Mazabuka District on the plateau, Bainbridge and Edwards reported that "The amount of run-off, coupled with sheet and gully erosion hat takes place during the heavy rains, is quite rightening." With much of their grass cropped right down to the roots, dambos along the upper reaches of rivers like the Lusitu are increasingly subject to abnormal flash floods. In the escarpment country eading down into the valley, the same authors refer o air photographs that "show clearly the denu-ation of the protective strips of woodland along he stream banks and the spreading of the cultiva-ion away from the streams up the steep slopes." Without a protective cover, flash floods each year emove more of the soil, with the authors estimating hat within ten to fifteen years "there will no longer e sufficient soil left in the escarpment to carry the resent population." In the valley, flash floods pe-iodically sweep the now unprotected banks of the ajor tributaries. When the Lusitu rose to record eights in a matter of hours in March, 1963, the xtensive riverbank areas under cultivation since elocation were severely eroded. Clearly, this would ot have occurred if the riverine fringe vegetation ad not been systematically removed through the upper, lower, and perhaps middle reaches of the Lusitu. The second type of erosion control would stress the construction of contour ridges to keep relocation-area soils *in situ*.

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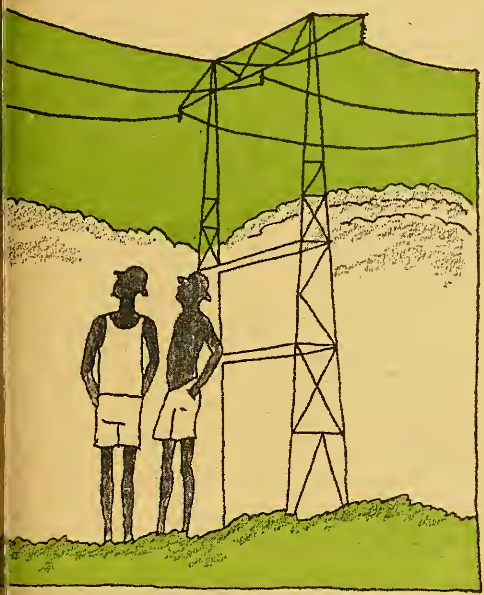
[1] This land consists mainly of deep woodland soils which had been only partially cultivated prior to relocation. Though their origin is still in doubt, apparently Bainbridge and Edwards (1963) believe that they were derived from non-karroo parent material, being transported into the valley from the adjacent escarpment and plateau. Mostly sandy clays, they are quite susceptible to erosion.



The core of the program of intensification was a two- or four-crop rotation supplemented by the use of cattle manure, applied on departmental demonstration gardens and on the holdings of Peasant Farmers and Native Authority Improved Farmers. The first ten Peasant Farmers were selected by the District Commissioner in 1959. After receiving credit from a revolving fund under the DC's jurisdiction for their equipment and cattle needs, they became the responsibility of the Department of Agriculture. At first, each Peasant Farmer was restricted to a 20-acre holding. While building this up, he was supposed to follow a four-crop rotation, involving equal acreages of maize, sorghum, cotton, and a green-manure crop. Supplemental manure (at three tons per acre) was to be applied annually to half the acreage planted in grain, with each farmer told to build up a herd of twenty cattle to meet his ox traction and manure needs. The NA Improved Farmers had much smaller holdings on which they could receive a one pound sterling bonus per acre, provided they followed a simple, grain-legume rotation and manured half the grain plot each year.

If actually practiced, the recommended measures most likely would have been effective in maintaining soil fertility and preventing erosion. However, the degree of acceptance by the farmers has been minimal. No ordinance prohibiting cultivation within 25 yards of tributary beds was enacted. Even if it had been, it is unlikely that enforcement would have been possible. Throughout their known history, the Tonga have always cleared tributary banks, except for occasional shade and fruit trees, in order to cultivate the fertile alluvial soils. After relocation and the loss of Zambezi and delta alluviums, these soils became even more desirable, with tributary-bank clearing extended throughout much of the valley. While those Tonga involved were well aware of the resulting dangers of erosion, they saw no option but to continue as in the past, since no acceptable substitute for riverbank cultivation was presented to them.

While contour ridging was not actively opposed, the Native Authority was unwilling to back it publicly through its own regulations. Well aware that the valley residents did not really understand the basis for contouring, the Native Authority did not wish to associate itself with a potentially unpopular measure, since their support had always been low, especially after this relocation, which the NA councilors and chiefs had been pressured into supporting by the central government. Though some 1,230 miles of ridges, protecting 14,247 acres, were dug under the jurisdiction of agricultural staff members by October, 1964, they never received popular understanding, let alone sufficient support to provide for their maintenance. A year later, construction of the ridges apparently stopped in the Lusitu area, and thereafter I recall seeing only occasional references to them in agricultural reports. Though I do not know how these ridges are faring today, some Lusitu farmers broke them down in connection with the cultivation and extension of their gardens.

Intensification in the valley has fared no better as a degradation control device. Out of a total district farming population of well over 10,000 men, to the best of my knowledge there have never been more than 25 Peasant Farmers and 75 Improved Farmers. Moreover, the degree of intensification among these has decreased, if anything, through the years. According to the Agricultural Assistant at Lusitu, in 1965, those wishing to become Rural Council Improved Farmers wanted to grow unrotated cotton. In 1967, most Peasant Farmers had sown cotton or maize in plots that they were supposed to plant in green-manure crops. In the Kayuni block of the Lusitu, the most enterprising of the five Peasant Farmers was monocropping cotton during a four-year period, after which he planned to carry on a cotton-maize rotation. He had also stopped applying manure, although here the reason, as with other progressive farmers, was the breakdown of his Scotch cart, for which it was literally impossible to get parts owing to the Rhodesian crisis. Moreover, he had substantially increased his acreage with twenty acres now planted in cotton and nine in maize, versus only three in sun hemp and one in groundnuts during the 1966-67 season. As for the application of manure at the village level, no one in the village that I have been observing over the past ten years had applied it during the previous season or any other season. The same applied to any form of rotation. Indeed, I doubt that it is an exaggeration to state that no more than 1 per cent of the valley farmers have ever regularly practiced either animal manuring or crop rotation.

The present relocation areas just cannot support the existing population under these agricultural practices. In South Mwemba, the population has exceeded the carrying capacity of the land, and is once again subject to periodic food shortages that are bound to get worse with time. To prevent this, the government has decided to again relocate at least 6,000 people, and it is only a matter of time before this resettlement occurs. Elsewhere, the situation is still within the control of the local population, since exhausted fields can still be replaced by uncultivated land around the margins of the relocation areas or in the few areas that have yet to be settled. On the other hand, I expect all available land to be utilized within the next ten years unless there is a major reduction of population or a change in agricultural techniques. In the highly favored Lusitu area, the surplus population is already crossing into the previously unsettled Mpendele-Mutulanganga area. Although no one in my own Lusitu study village had joined this movement by 1967, some of the men had begun to clear distant gardens on the far side of the Lusitu. In all cases, no intensification was occurring; rather pioneer farmers were simply re-establishing the same extensive system of bush fallow cultivation.

Although the problem outlined in the last few paragraphs is a severe one, it is not my purpose in this paper to propose possible solutions. Rather I wish to emphasize, in closing, that what we are dealing with here are two incompatible systems of agriculture. One, proposed by the Department of Agriculture, is satisfactory from an ecological point of view, except that it is not acceptable to the farming population. The other, while satisfying to the farmer, has serious, indeed catastrophic, ecological implications under present population conditions. The problem is to design a compromise system acceptable to all involved.

Throughout Africa, research stations have tended to develop new techniques without taking into consideration the total context within which the farmer, for whom these techniques are designed, lives. Ecologists, I think, tend to make a similar mistake when they propose alternative land-use systems without asking the questions, "Can these support the existing human population, which, after all, is the ecological dominant in the area?" Or, "If not, is there an alternative way of life available for the people, which they are likely to accept?" If, for example, cattle pastoralists are to be driven out of an area to be used for game cropping or conservation purposes, the same concern must go into planning an acceptable future for them as relates to other communities within the habitat. Failure to do this is not only morally indefensible, but is also apt to be politically unacceptable. In other words, a technical or ecological solution to problems of environmental degradation is not of much use unless it is understood and implemented by the relevant people at the local and national levels.

BAINBRIDGE, W. R., and A. C. R. EDMONDS. *Northern Rhodesia Forest Department Management Book for Gwembe, South Choma and Mazabuka Districts*, 1963.

SCUDDER, T. *The Ecology of the Gwembe Tonga.* (*Kariba Studies*, Vol. II), Manchester University for Rhodes-Livingstone Institute, 1962.

———. "The Economic Basis of Egyptian Nubian Labor Migration." *A Symposium on Contemporary Nubia*, ed. R. FERNEA. HRAF Press, New Haven, 1967.

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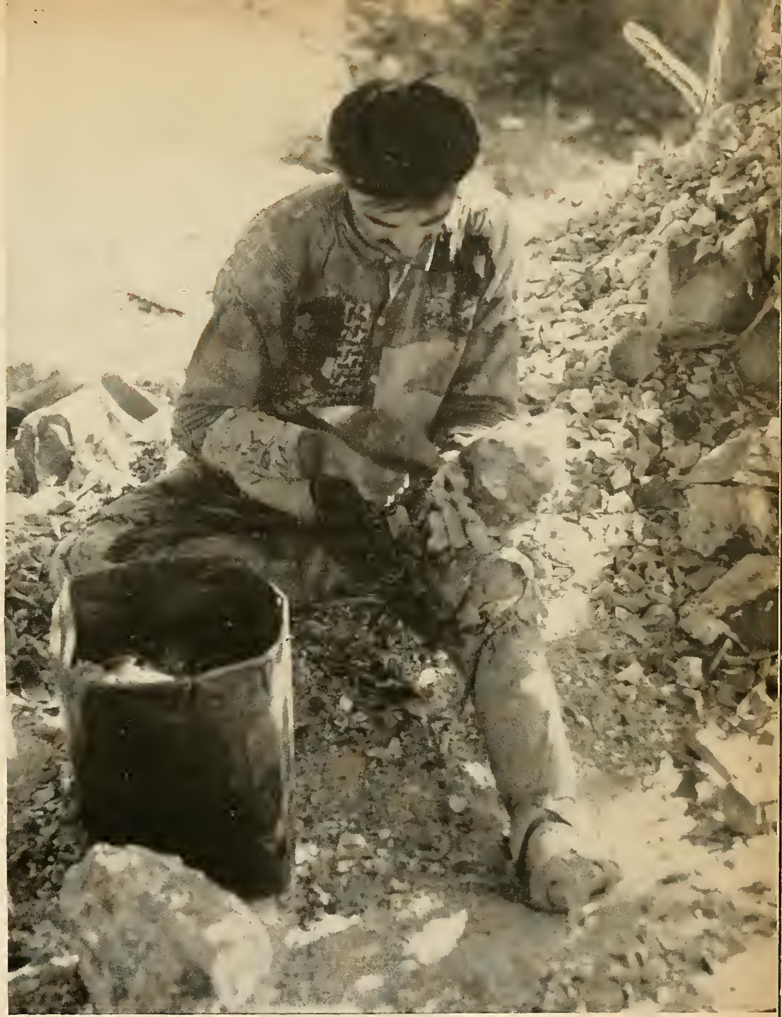
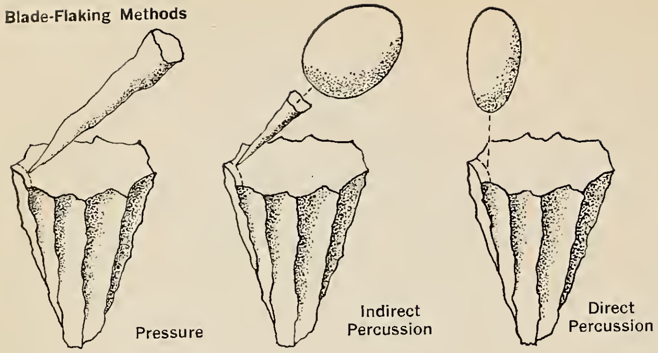


small village in northwestern
key, a group of men are con-
g a Stone Age tradition. They
at knappers, and their method
aining blades from a piece of
alled a nucleus, sheds light on
hnique used by stone knappers
Upper Paleolithic some 35,000
ago.

st stone tools belonging to
Paleolithic man were made
elongated flakes, or blades, of
Archeologists have different
however, about how these
st stone knappers struck blades
the nucleus. One view is that
; and sudden pressure was ap-
near the edge of the nucleus with an implement of antler, bone, or hard wood, the force of the pressure removing the blades. A more prevalent view is that two implements were used: a stone hammer and a punch of antler, bone, or wood—the punch serving to transmit the force of the blow very precisely (indirect percussion). Archeologists are also aware that prehistoric knappers could have used direct percussion with a stone hammer, but it is generally assumed that this would not have provided sufficient accuracy to obtain thin blades from the relatively narrow top of the nucleus.

However, the third method, direct percussion, is the one used by today's Turkish knappers, and I feel this has strong implications about the technique of Stone Age man. The accuracy and regularity with which the Turkish knapper flakes off blades with his hammer is quite remarkable. It suggests that a skilled prehistoric worker could have used the direct percussion technique—simply with hammerstone or perhaps hammerstone plus hafted handle—with much greater accuracy than archeologists have generally expected.

A number of hammerstones have been recovered from Upper Paleolithic sites, but none of the postulated punches or pressure tools have been found, and early man's use of such



Direct percussion is used in Turkey today, and this efficient method was probably more prevalent during the Upper Paleolithic than archeologists generally believe.

implements remains hypothetical. So, because the question of which method was most widely used is still open, it is extremely instructive to observe the Turkish flint knappers. Their skill is based on tradition and years of practice, and they provide the archeologist with a sort of "laboratory" for the study of knapping technique. They are, by far, the most important group of flint knappers working today. The only others are a few archeologists who are proficient in flint knapping, one or two remaining gunflint knappers who work mainly for antique gun collectors, and the rapidly disappearing flint knappers of a few remaining aboriginal societies in remote areas, such as those in Australia (NATURAL HISTORY, February, 1968).

Despite the ancient method of producing the Turkish blades, the present-day farmer in that country depends on them for efficient threshing of his wheat. In fact, any visitor to an agricultural area in Turkey during harvesting season has probably seen the small flint blades in use, although he may not have realized it, for they are inserted into the bottoms of threshing sledges. Each sledge, containing six hundred to eight hundred blades, is drawn in circles by a horse or team of oxen over the harvested wheat until the flint edges have separated the grain and chopped up the stalks.

Such flint-studded threshing sledges have been in use for several thousand years in the Middle East. One might ask why this ancient, primitive tool, called a *döven*, is still so popular in Turkey. The fact is that threshing wheat with *döven* has several advantages over other threshing methods. It is far more efficient and quicker than either parching (scorching off the chaff) or pounding in mortars, probably the earliest methods used. It is faster than beating with sticks or flails. While there is a method faster than the *döven* that is common to other areas of the Middle East—driving large numbers of hoofed animals over the wheat—it is wasteful of human and animal labor. The *döven*, on the other hand, is pulled by only one horse or a team of oxen, and is driven by only the oldest or the youngest members of the family. This frees the ablest adults for the more physically demanding tasks of harvesting. Another reason for the continuing popularity of the *döven* in an age of increasing mechanization is that it can be transported easily to the most isolated villages over roads where wheeled agricultural machines would most likely come to grief.
Moreover, it is inexpensive and re
quires little maintenance.

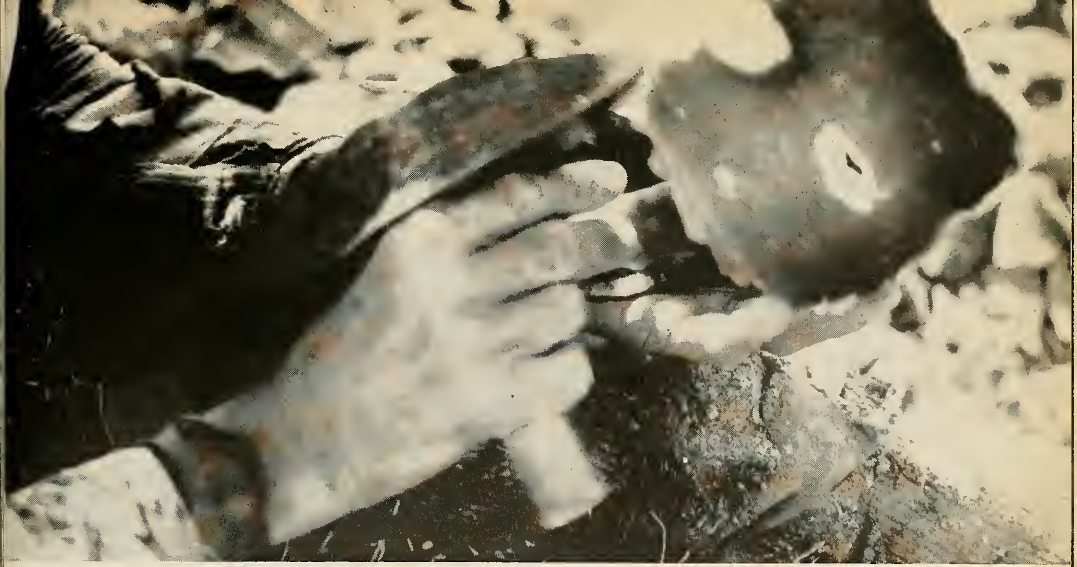
The *döven* are made throughou
Turkey in small towns by specialist
However, all of the flint used in thei
manufacture comes from the villag
of Cakmak (pronounced tshakmak
It is here that one can observe th
interesting survival of Upper Pal
olithic blade-nuclei flaking.

Cakmak is located approximatel
thirty miles south of the large tow
of Bursa. A guide took me to th
Cakmak quarry from Harmancik,
neighboring town. Getting there ha
not been easy, and since the knappe
work irregularly during the summe
I was worried that the opportuni
to see them might be missed.

However, as I approached the to
of the wooded hill where the flint
extracted, I was reassured by th
quasi-metallic sound of flint bei
chipped. Two men were working
the shade of an open, branch-co
ered shelter that had been erected
top of a huge pile of flint debris. B
tween the trees, many other fli
heaps, some as high as ten feet, cou
be seen dotting the entire area. Ne
the base of the knappers' heap was
thirty-foot-deep, vertical flint pit.

The two knappers had ju
brought up a dozen large pieces
flint, about a cubic foot each, fro
their pit that morning. The flint
light gray with a blue or green hu
but when it is brought out of the
it is covered with a chalky crust. Th
is removed when the flint is prepar

Large chunk of flint is first quartered into pieces, or nuclei, one of which is held in knapping position, far right; blades are made by hitting nucleus edge.



After each blade falls into his hand, the knapper removes it, while rotating the nucleus into position for the next blow.

knapping. The stone has a me- m-fine texture, and is relatively e of impurities and inclusions. Like all good flakable stone used knappers, flint, because it is ho- geneous, has no natural plane of avage. Thus, force applied at one nt spreads uniformly through the terial. As can be observed on the es of plate glass, homogeneous terials break with a conchoidal cture; that is, with a slightly ved, rippled surface. There is also welling near the point of impact, wn as the bulb of percussion.

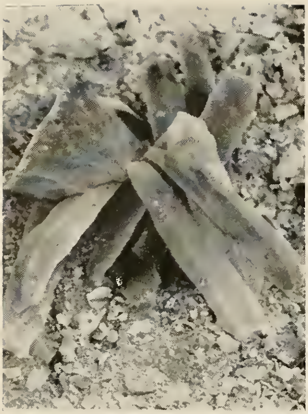
ince all flakable material varies texture and resilience to shock, the knapper must use particularly suited implements and techniques to obtain the desired results. The first operation consists of quartering the flint into pieces (nuclei) of about six to eight inches. from which the blades will be knapped. Quartering is done by holding the flint firmly on the ground with the left hand and striking it with a short-handled, double-headed hammer made of forged iron. Once the flint has been quartered, the worker can begin knapping off the blades, the most interesting part of the operation.

Although the knappers use such modern implements as metal hammers, and obtain far more uniform blades than the Upper Paleolithic knappers, the methods are essentially the same. Now, as then, blades are detached from the edge of a nucleus whose base serves as a striking platform. The blades are removed one by one by blows aimed near the edge of the nucleus, along a spiral line that remains parallel to the edge as the knapping progresses.

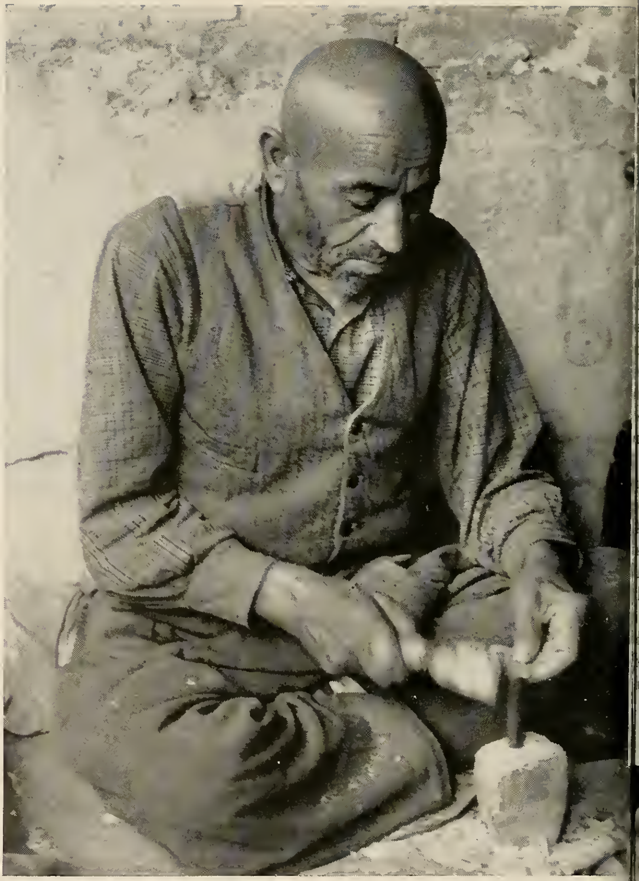
The worker I observed held the flint nucleus in his left hand, and starting at a corner of the base, detached the blades with a metal hammer as he turned the nucleus.

The knapper sits with his left leg extended forward: the right leg is bent toward his body with the foot under the left thigh, raising it slightly. The left hand (which holds the nucleus) rests on the inner edge of the knee, while the arm rests firmly against the left thigh and left side of the torso. The nucleus is held in the palm of the hand, which is protected by a guard made of one layer of soft leather and two superposed pieces of auto tire.

The Cakmak knapper thus provides a firm, but resilient support for the blank, since the shock of the



Finished blades surround exhausted nucleus, above. Before insertion into threshing sledges, they must be retouched by döven *maker, right.*



knapping blow is partially absorbed by the fingers, the palm padding, and by the thigh and the knee. A less resilient hold and support would cause the nucleus to rebound after impact, breaking the blades short. Another advantage of this type of hold is that it allows the knapper to compensate for diminishing inertia, due to loss of mass of the nucleus, by gripping it harder with his fingers when the blow is struck; in that way he continues to obtain uniformly good blades.

The hammer is of forged iron, hafted to an eight-inch wooden handle. The head is pointed at both ends and weighs about three pounds, giving it appreciable momentum. The stoneworker raises the hammer six to eight inches, bends his wrist slightly backward, and strikes the base of the nucleus with an easy follow-through movement. The blow is struck at an angle somewhat less than the perpendicular, approximately one-quarter to one-third of an inch above the edge of the nucleus, and generally just above the ridge formed by the intersecting scars of the two blades previously removed.

The detached blade, which measures from three to five inches, depending on the size of the nucleus being worked, drops into the palm guard. The knapper then raises the nucleus one or two inches while removing the blade with his right hand, which still holds the flaking hammer. He simultaneously rotates the nucleus slightly with the fingers of the left hand readying it for the next blow. The operation is performed quickly, but without haste, the regular movement of the hammer giving it rhythm. The exhausted nucleus is about four to five inches long, almost perfectly conical in shape, and shows on its sides the concentric fluting marks of the last blades removed.

Experimenters interested in prehistoric flint-knapping techniques have shown that when hammers are made of materials less dense tha
metal or stone—such as antler, bon
or hard wood—the flakes obtain
have a less pronounced bulb of pe
cussion and are proportionate
longer and more slender. The Ca
mak knappers obtain such blad
even though they use metal hamme
probably because the iron is qui
malleable and relatively soft; this
evidenced by the crushed ends of t
quartering hammer and the blunt
points of the flaking hammer. T
thickness of the bulb of percussi
also seems to depend on the type
flint being used. In some cases, esp
cially when the flint is grayish bl
the edge of the nucleus almost
sembles a toothed gear wheel becau
of the deep indentations of the bu

rs. The fragile, serrated overhang s formed impedes the proper re- val of the blades. It would appear m examining a number of blades, hough I have not observed this in field, that the knapper removes s overhang when necessary with ew taps of the hammer before pro- ding further.

If enough flint has been dug be- ehand, a good knapper can, in one y, fill seven or eight five-gallon ns, which amounts to almost 500 unds of flint blades. If the mining s to be done at the same time, the duction is half that amount, pro- led the pit is already open. When cans are full, they are emptied at foot of the waster mounds into a all, roofed enclosure.

The production of the village appers—about 500 tons a year—is ght by merchants from Harman- who pack the flint blades in can- bags and send them to *döven* kers throughout the country.

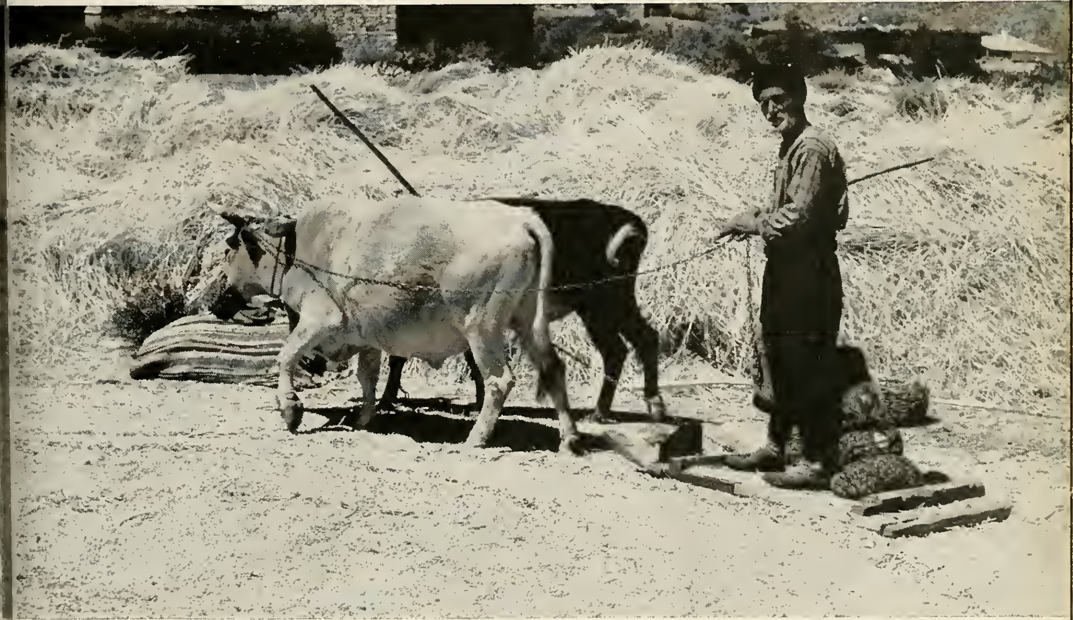
efore the blades can be inserted the *döven*, they must be further uced to a uniform shape and size. *döven* makers do this them- ves. I observed the procedure in Konya, a large town in south central Turkey, the heart of the most important agricultural region. The *döven* maker held the blade by its bulbar end, placed it on an iron anvil, and using the face of a rectangular piece of forged iron set into a wooden handle, he removed relatively thick, short flakes from the edge of the blade. When he had finished, the *döven* blade had a nearly ellipsoidal shape, and was about 1¾ inches long by 1½ inches wide.

The *döven* itself is made of two joined wooden planks. On its underside 600 to 800 slots had been chiseled. The *döven* maker filled all of the slots with the retouched flints, driving them in with a few blows of a metal hammer. The *döven* was now ready for sale.

Judging from the quantities of flint blades knapped at Cakmak, I estimated that about fifteen to twenty thousand *döven* are manufactured each year in Turkey. This figure seems reasonable judging from the large number of *döven* that one sees on the threshing grounds of most Turkish villages at harvesttime.

These farmer-craftsmen, practicing in rural Turkey of today a technology as old as man himself, will probably stay busy for a long time to come and outlast the few remaining flint knappers elsewhere in the world. For the archeologist, as we have seen, the opportunity of studying this unique community offers important clues to the tool-making methods of Stone Age man. Ultimately, the answer to which knapping method was more prevalent during the Upper Paleolithic will depend, first, on the results of careful studies of the nuclei, blades, and by-products in archeological collections—few of which have yet been examined from this point of view—and secondly, on the results of systematic experimentation. From these preliminary observations, however, it is apparent that direct percussion—a simple and efficient method of knapping—might have been more widely used during the Upper Paleolithic than is generally assumed.

Threshing sledge rides in circles over the harvested wheat, while the 600 to 800 flint blades inserted into the bottom of the sledge separate grain from stalks.



SKY REPORTER

BIG BANG IN TROUBLE A slight but significant chink has appeared in the seemingly impregnable big-bang explanation of the origin of the universe. The chink is a difference of just 10 degrees in temperature, but it could be a universe of a difference.

The big-bang theory predicts that the universe should be bathed in the residue of the radiation emitted in the primordial explosion 10 billion years ago. This radiation should have cooled to minus 454 degrees, just six degrees above absolute zero.

In 1965 scientists at Bell Telephone Laboratories detected radiation at microwave wavelengths equivalent to just this temperature. Subsequent observations at adjacent wavelengths confirmed the observation. and the big-bang school seemed to have carried the day.

However, to measure far infrared wavelengths (between the visible and the microwave on the electromagnetic spectrum) scientists must send detectors above our blanket of air. Just a year ago, a trio from the Naval Research Laboratory and Cornell rocketed detectors 100 miles high to measure the background radiation at such wavelengths. Writing in *Physical Review Letters* last November, they reported their results—the background radiation was minus 444.5 degrees. While only 10 degrees higher than the microwave readings, this temperature is equivalent to 30 times the energy that had been predicted for the shorter wavelengths.

The three scientists emphasized that they had accurately measured real radiation, but added that they were not as sure of its origin. They also stressed that they were working with a single observation. At the moment. however, a lot of people are heading back to their computer consoles.

PULSAR SECRETS Just a year after their discovery, the pulsars (pulsating radio sources) may be yielding their secrets—and their secrets may be just as exotic as some of the guesses made in the initial excitement. At the same time they are becoming common objects; the Galaxy may be littered with them.

The exciting thing about pulsars has been the short time scales involved. Astronomers are accustomed to dealing in years. generally millions of years. Their shortest time scales have been days, for short-period variable stars, or hours for eclipsing binaries.

Pulsar phenomena are measured in fractions of a second. The first four discovered had periods of a quarter of a second to two seconds; the next half dozen all fell within that range. The very short time period implied that the source was something very small; the strength of the signals implied great energy.

Theorists immediately suggested neutron stars. Neutron stars are (or were) hypothetical objects formed when a massive star collapses in on itself. The electrons of the atoms are mashed into the nucleus. combining with the protons there to form neutrons. No space is left as there is between the atoms of normal matter; a cubic inch of a neutron star would weigh millions of tons. It is thought the remnants of a supernova may collapse inward and form such an object.

Thomas Gold of the Center for Radiophysics and Space Research at Cornell proposed last May in the British journal *Nature* that neutron stars might account for the pulsars. He described how such an object, spinning rapidly, might accelerate an accompanying cloud of ionized gas to near the speed of light within an intense magnetic field. While Gold said he could not identify the mechanism for emitting the radio pulses, he added they could derive their energy from the rotation.

The rapid rotation also would explain the short period; the neutron star and its gas cloud would be like the rotating beacon in a lighthouse.

Gold suggested that radio observatories search fo pulsars with shorter periods (up to a hundredth of a second). He also suggested that friction would eventually slow the star's rotation, and proposed that it migh be possible to find a pulsar slowing down.

Both predictions have come true. Even neater. both have come true for pulsars associated with supernova remnants. Three Australian radio astronomers reporte last October that they had found a pulsar with a perio of nine hundredths of a second within the boundarie of the radio source Vela X, a supernova shell.

A month later at Green Bank, West Va., two pulsar were located in the Crab Nebula, the visually spectacular remains of the supernova of 1054. Astronomers a Cornell's Arecibo Observatory in Puerto Rico foun that one of these has a period of just three hundredth of a second. A week later the Arecibo group droppe its bombshell: The pulsar was slowing down by abou one part in two thousand per year.

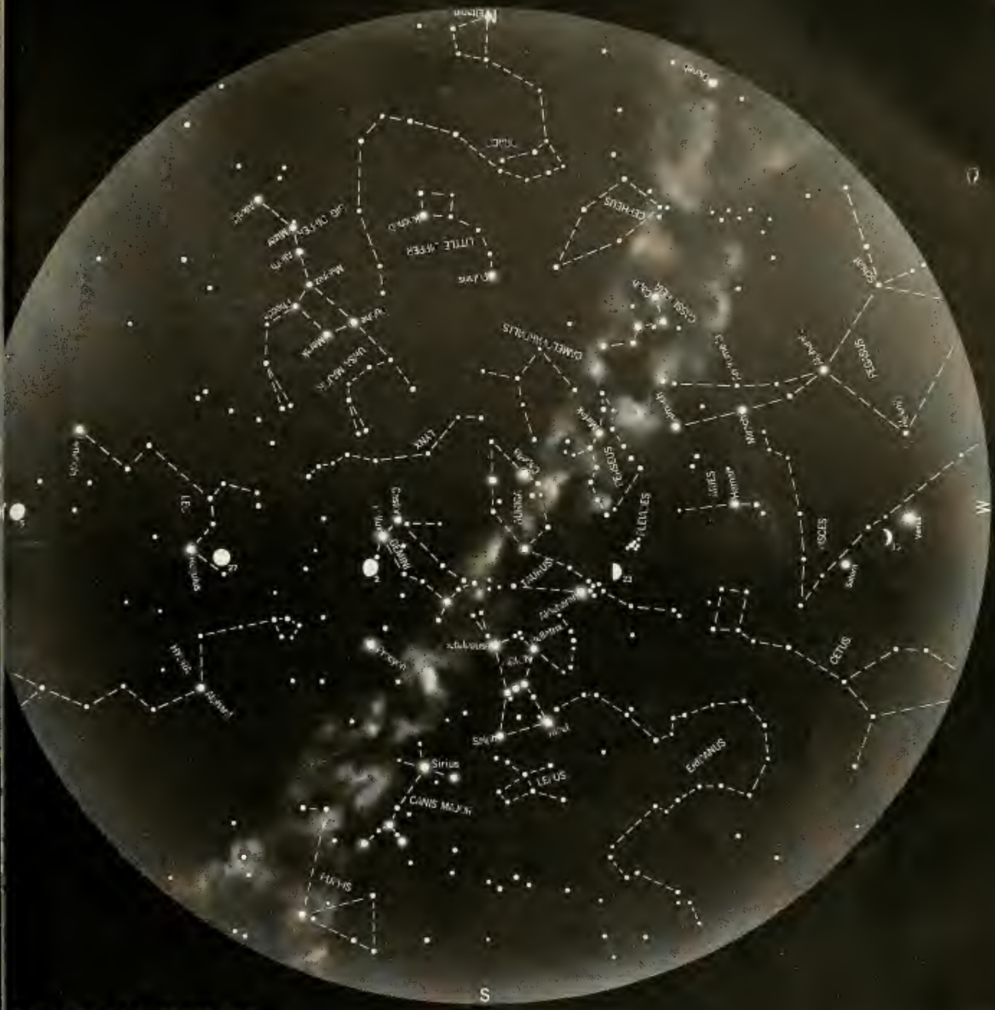
Attention now swings back to Vela X; if that pulsa shows evidence of slowing, the pulsars may have bee explained. Theorists believe that supernovae occur i our Galaxy about once a century, a rate that would r sult in some 100 million neutron stars by now. Som perhaps most. may have passed through the pulsa stage. The oldest current pulsars may be pulsing at th maximum observed rate, once every two seconds or s The youngest and rarest may be pulsing 100 to 20 times a second.

NEW EYE IN TEXAS A 107-inch reflector te escope designed for planetary work, temporarily th third largest in the world. has been dedicated at th McDonald Observatory of the University of Texas.

The new telescope is the larger of two commission for solar system work by the National Aeronautics ar Space Administration. An 88-inch reflector is neari completion on Mauna Kea in Hawaii.

In the 1970's a new generation of large telescop will come into operation, perhaps consigning the Tex reflector to the "medum size" bracket. Mirrors of 1 inches are planned in Arizona, Australia. and Chi And the U.S.S.R. is moving ahead with its 236-inch te scope, taking Palomar's title of "world's largest."

John P. Wiley, J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AURIGA
Capella
GEMINI
TAURUS
Aldebaran
ORION
Rigel
Saiph
CETUS
HYDRA
Procyon
Sirius
CANIS MAJOR
LEPUS
ERIDANUS
PUPPIS

CELESTIAL EVENTS

The full moon occurs in February on the 2nd. Thereafter, there will be a last-quarter moon in the morning sky on the 9th, a new moon on the 16th, and the evening crescent moon should be visible from the 18th until first-quarter on the 23rd. The waxing gibbous moon will be in the evening sky late in the month.

Venus is a prominent and brilliant evening star, high in the southwest during twilight and setting about four hours after the sun. Saturn, also an evening star, is to the left and higher than Venus and sets later. Jupiter is in Virgo and rises about three hours past sunset; Mars, in Libra, rises shortly after midnight.

February 5-6: Jupiter is near the waning gibbous moon, rising after the moon and following it across the sky on the 5th, rising first and preceding the moon westward on the 6th.

February 7: The bright star Spica and the moon rise lmost together about 11:00 P.M., but separate slowly as hey move up the sky.

February 9: Mercury, in the morning sky, becomes stationary in right ascension and resumes direct (eastward) motion.

February 10: Mars is located above the rising crescent moon in the southeastern sky during the early morning hours today. Do not confuse Mars with the star Antares, similar in color and brightness to the planet but well to the left of the moon this morning.

February 18: Venus will be above and to the left of the slender crescent moon when it appears in the southwestern sky this evening; the moon will move closer to the planet before both set after 8:00 P.M.

February 19: Saturn is to the right and below the moon in the southwest during early evening.

THOMAS D. NICHOLSON

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 9:15 P.M. on February 1; 8:20 P.M. on the 14th; and 7:25 P.M. on the 28th; but it may be used for about an hour before and after those times.

Fledgling oilbirds (Steatornis caripensis) *remain silent as adult lands at nest in Trinidad's Diablotin Cave.*

BIRD OF DARKNESS

by Jan Lindblad

In 1799, Alexander von Humboldt, famous explorer and naturalist, was led by a group of Venezuelan Indians to a large cave near the town of Caripe. Inside the cave, Humboldt and his party were confronted with an unlikely clamor, the clicks and screams of hundreds of hovering blue-gray birds, large creatures with a three-foot wingspread, frightened by the invasion of their nesting place. Guacharos, or crying birds, the Indians called them. In English they are named oilbirds for the fat bodies of the young, which the Indians boiled down to provide oil for cooking and for lamps. Today, the oilbird is found nesting in caverns in tropical South America and the Caribbean, from Peru through Ecuador, Colombia, Venezuela, Guyana, and on the island of Trinidad.

The oilbird is nocturnal. During daylight hours, the birds remain within their nesting caves, but as the evening hours approach, the adults leave their nests in search of food, emitting low-pitched "clicks" that echo from the cave walls. The eerie, clicking sounds and their reverberations permit the oilbird to orient within the cave, through a process of echolocation similar to the radar-like system of bats.

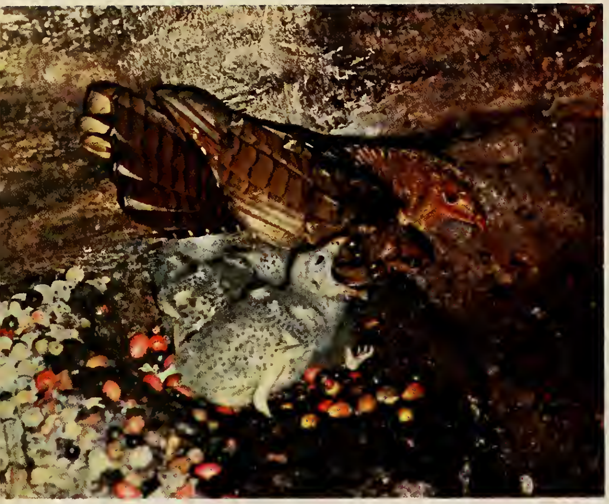
When looking for food, the gregarious oilbirds emerge from their home cave as a flock. Unlike most night-flying birds, which consume insects and other small animals, the oilbird feeds upon fruits, primarily those of the palm and laurel families. Returning to the cave, the adults resume the clicking sound as they negotiate through the winding cave passages to their nests.

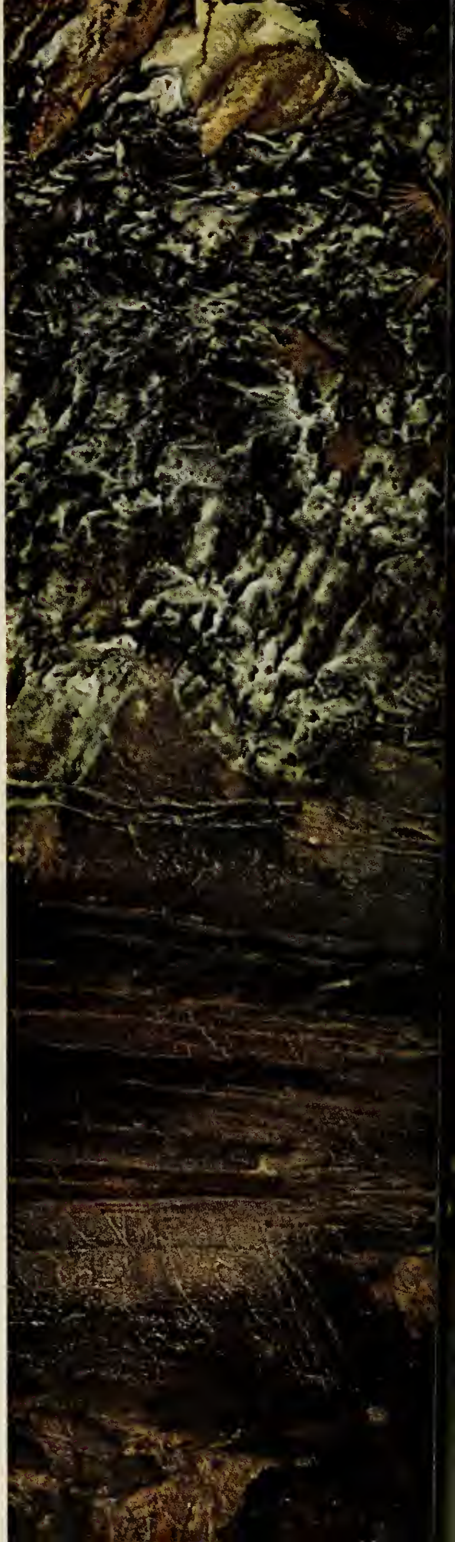
Young oilbirds remain silent as the parents approach, but when the adults light upon the nest ledge and brush against their brood, the offspring add their shrill, high-pitched squeaking to the din of the cave and nibble at their parents' plumage in their demand for food. During my observations in Diablotin, an oilbird nesting cave in Trinidad, I noted that the adult does not yield the food immediately but stands, head away from the young, for some seconds as the beaks of the juveniles continue to pick at the parents' plumage. This tactile exchange may aid the parent in distinguishing one nibbling beak from another and may also serve to protect its eyes from the beaks of the brood. Then, the adult quickly turns and thrusts its beak far into that of the juvenile; the beaks of young and adult remain interlocked for half a minute, as the food is deposited. When feeding is completed, the parents again depart and the cave remains silent until their return.

This process is repeated five or six times between dusk and daylight, depending upon the distance of the food source from the nesting cave. As the young swallow the pieces of fruit brought by their parents, they regurgitate the seeds and with a toss of the head, throw them out of the nest area and onto the cave floor. An analysis of the great mounds of fruit seeds in the Oropouche, Aripo, and Diablotin oilbird caves reveals that an adult may travel as far as fourteen miles from its home in its nightly food search.

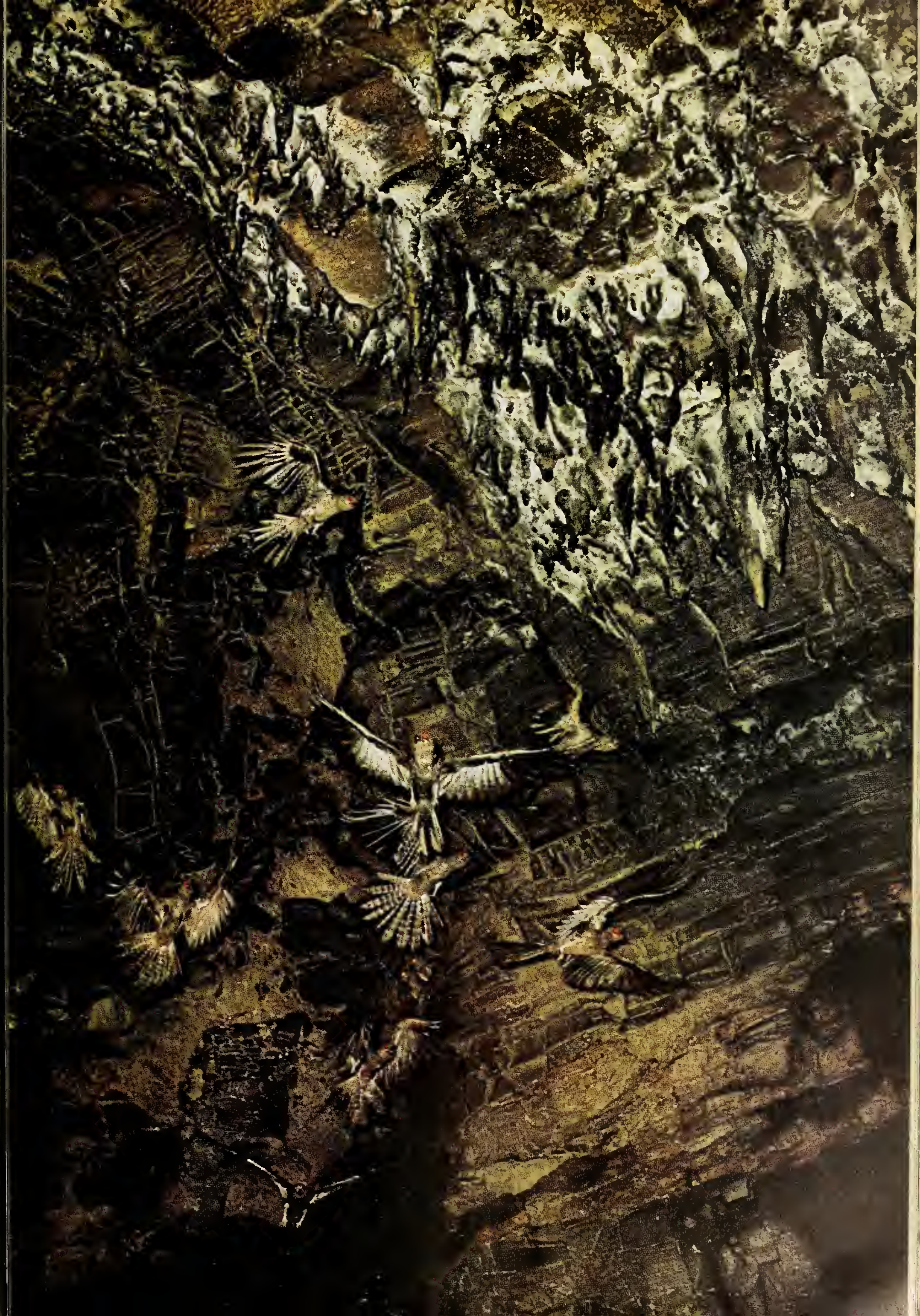
At birth, the young oilbird weighs about 15 grams. After ten weeks on the fat-rich fruit diet, they weigh up to 600 grams—some 200 grams more than the adult. At this age, the plumage of the young is still downy; the tail and wing feathers are short. But as the adult plumage continues to develop, the weight declines. When the birds are from 95 to 120 days old, they have "trimmed down" to the weight of their parents and begin to accompany the adults outside the cave. This is an extremely lengthy maturation period.

Oilbirds have excellent hearing and are equipped with one of the most well-developed and highly specialized nervous systems in the bird world. The elaborate system is necessary for the proper operation of the echolocation mechanism, which must function properly before the young adult takes its first plunge from the nest ledge into darkness. At some point in its evolution, the oilbird ancestor did not dwell in caves. While details of the transition to a cave-dwelling existence are unknown, it is suspected that the bird first nested in the semidarkness of cave mouths, where the danger of predators was less than outside these shelters. Even at that time, the oilbird probably possessed some mechanism—even if rudimentary and inefficient—for finding its way in poorly lit areas. Later, as the bird moved deeper into the safety of the cave's interior, its echolocation device improved until it reached its present complexity. Today, the bird lives in almost continuous darkness, seldom seen except by those who seek out its nesting caves.





After feeding, a young oilbird struggles to regurgitate a fruit seed, above. These brightly colored seeds surround the nest area and collect in great mounds on the cave floor. Right, oilbirds dart through the darkness of their nesting caves aided by a radar-like device, similar to that used by bats. Outside the cavern, the bird flies with swift powerful strokes, traveling several miles on its nightly food search.



Glaciers
n the American
West

Stephen F. Arno

ɪst glaciers in the western
ited States are confined to
ty cirques—glacial-carved
ɪressions in mountain ridges—
een at left.
ividually small, western
ciers collectively cover a
l of 200 square miles.

lor most of us, the word "glacier"
summons to mind the extensive
lad landscapes of coastal Alaska,
nland, or perhaps the Antarctic.
mental picture does not gener-
include those glaciers within the
iguous United States. Little won-
for even the professional litera-
usually ignores the relatively
l glaciers of the western United
s. Yet, there are about 1,000 ac-
glaciers scattered high in the
ntains of seven western states.
total area of these "rivers of ice"
rs about 200 square miles.

ost of the western glaciers are
l and are confined to the shady,
-sheltered portions of lofty
es—the cup-shaped amphithea-
that were scooped from high
s by grinding ice during the
ice ages.

t there are exceptions. In moun-
eadwaters of the Pacific North-
lie glaciers of the valley type
are up to three and four miles
—such as Hoh Glacier in the
pics and several others on the
s of extinct volcanoes in the
Cascades. The compressed ice in some of these is nearly as thick as the Empire State Building is tall.

Glaciologists believe that most of the smaller western ice fields were created during the "little" ice age, a relatively brief cold period that ended about 2,500 years ago. But some of the larger glaciers in the Northwest appear to be ancient remnants of the last great ice age, which ended about 10,000 years ago.

In any case, we've learned that glaciers are sensitive indicators of climatic change. If the mean annual temperature drops only one degree Fahrenheit, glaciers are likely to advance: to become longer and thicker. Their downhill motion, called "flow," may also increase. A moderate increase in mean annual snowfall has a similar effect. Conversely, a slight increase in temperature or a decreased snowfall causes glaciers to shrink, or retreat. Like their larger Alaskan counterparts, the glaciers of the western United States retreated markedly from the late 1800's until about 1950. Since then, however, many of these ice fields—particularly some in the Washington Cascades and Olympics—have held their own or have even advanced. While we cannot be certain, it appears that increased summer cloudiness, extremely heavy snowfalls, and generally lower temperatures contributed to this advance.

However, most glacial ice fields in the western mountains are so small that their movement is difficult to measure. Moreover, there is much confusion as to just what criteria decide whether a body of ice qualifies as a glacier. Webster defines glacier as "a field or body of ice, formed in a region where snowfall exceeds melting, and moving slowly down a mountain slope or valley."

This indicates that glaciers might form only in mountains that rise above regional snowline—where more snow falls in winter than can melt away in summer. In the coterminous United States, only a small portion of the glaciers in the highest Cascades and Olympic Mountains seem to meet this qualification, yet many other mountain ranges contain what most glaciologists consider to be full-fledged glaciers. Indeed, the vast majority of western glaciers rest in the lee of steep ridges where local snowfall is supplemented to a considerable extent by frequent avalanches and snowslides. In time the snow is converted to ice, and this becomes so thick that tremendous pressure is exerted on the bottom layers. The ice then begins to flow very slowly, probably somewhat like pancake batter. On flat terrain, where the compressed ice moves laterally instead of in a downhill direction, an ice field might have to be 200 or more feet thick before the pressure could create this glacial flow. Mountain glaciers, however, usually occupy steep slopes where gravity exerts an additional downhill force aiding glacial movement. Therefore a glacier may be active when it is roughly only 100 feet thick.

Flow is the truly definitive characteristic of a glacier. But with the ice moving no faster than perhaps two feet per year, how does one detect the flow and thereby prove the ice is glacial? Nearly a century ago, naturalist John Muir used a simple and direct method when he discovered the Sierra Nevada glaciers in California. He pounded a line of wooden stakes straight across the middle of an ice field, where the maximum movement occurs. (A glacier's front margin may remain stationary or retreat due to melting, while its internal ice continues to move forward.) If he returned the next summer and found that the straight line was now curved "downhill," he would have proof that the ice had moved.

Several phenomena attend the life of a glacier. In glaciers, the highly compressed ice toward the bottom flows more readily than the layers higher up. Consequently, when the lower ice moves, it causes the upper, more rigid layers to crack and form giant crevasses. One specific form of crevasse, called a "bergschrund," separates the moving ice field from the body of permanent snow farther up the slope. Fresh moraines, piles of rocky debris that the glacier has carried with it, are located along or near the front margin (snout) of the ice. The water flowing from this melting snout retains a milky appearance far downstream because it carries pulverized rock fragments (rock flour) that the glacier has ground off the bedrock underneath it. Distinctive features can also be noticed at the upper end (head) of the active glacier, where its new supply of ice will form. A layer of the past season's snow remains atop the ice at the end of the melting season, in late September, and the volume of accumulation will be at least as great as that of ablation (melting) if the glacier is growing. The firn line separates the zones of accumulation and ablation. As the snow becomes ice this curved line becomes a sort of annual "ring." Viewed from above, many of these lines can usually be seen strung along the glacier down toward its snout.

An ice field can be called a glacier only as long as it remains active. If enough ice melts so that the bottom layer no longer flows, the ice field will stagnate and become a remnant of glacial ice. Such remnants are found today in mountain ranges of the West where the last real glaciers died out decades ago.

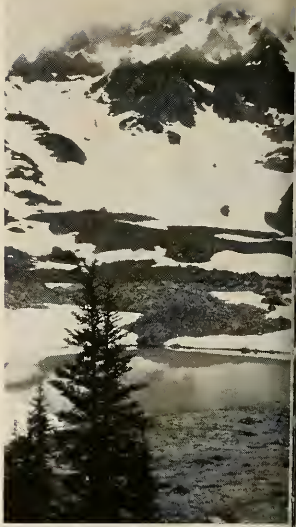
GLACIER LOCATIONS

All glaciers in this country (outside of Alaska) are located west of the 105th meridian (*see map*). They are more abundant in the northern part of this area, where summers are short and where the sun does not shine from directly overhead. Tremendous winter snowfalls, coupled with cool, calm, cloudy summers in the maritime Pacific Northwest, make that region ideal for development of glaciers. Therefore it is not surprising that fully three-quarters of all the West's glacier-covered area is found in the western half of the state of Washington.

WASHINGTON

Snowfall is so heavy here—averaging about 600 inches per season at Paradise Ranger Station at an altitude of 5,500 feet on Mount Rainier —and summers are generally so humid and cool, that some good-sized glaciers have even developed wholly within the forest zone, below tree limit. This phenomenon apparently does not occur elsewhere in the Northern Hemisphere. A good example of a low-altitude glacier in the Olympic Mountains is Anderson Glacier on the south slope of 7,321-foot Mount Anderson. This ice field is a mile long and lies at an elevation of between 4,900 and 6,000 feet, while conifers in the area extend upward to about 6.200 feet.

One of the first sightings of western glaciers was made in 1792 from shipboard by British Captain George Vancouver when he was sailing up Puget Sound—probably about 70 miles away from the giant, ice-covered volcanic cone which he named Mount Rainier. Mount Rainier (14,410 feet) towers 8,000 feet above the regional snowline, so it has vast terrain for accumulation of snow and nurtures the West's biggest ice fields.



Despite their relatively modest
elevations (under 8,000 feet)
Washington's cloud-capped
Olympic Mountains contain ov
60 glaciers. The combination
extremely heavy precipitation
and cool, cloudy summers
contributes to the ice fields
in this peninsular range.

According to Dr. Mark Meier of the U.S. Geological Survey the Carbon-Russell glacier system on Rainier is essentially a single valley glacier fed by two tributaries; it is nearly six miles long, and it covers five square miles of the great volcano. The snout of Carbon Glacier extends down to the low elevation of about 3,350 feet, quite possibly the lowest altitude for any glacier at this latitude (47° N.) in the Northern Hemisphere. A total of 41 glaciers cling to the flanks of this one immense mountain. The rugged back country of Washington's Olympic Peninsula also contains glaciers. Considering the low elevation of the Olympic Mountains (the highest peak is under 8,000 feet) the extent of ice fields here seems even more dramatic than on Rainier. While the average altitude of the smallest glaciers on Mount Rainier is about 7,300 feet, the elevation for western Olym glaciers is just 5,600 feet. The U Geological Survey recognizes 61 t glaciers hidden away among th remote, cloud-capped crags, althou more recent studies of aerial pho graphs indicate that there may several more. Using dynamite-e techniques. Dr. Ed LaChapelle of University of Washington found t the 2.6-mile-long Blue Glacier Mount Olympus has a maxim thickness of some 900 feet. The m active ice in this glacier flows a hundred feet per year.

Glaciers in the Olympics North Cascades receive from 15 200 inches of annual precipitat The North Cascades—between vens Pass, U.S. Highway 2, and Canadian border—harbors aln half of our western glaciers. To this great concentration of active tinues to sculpture the stark gran- in the vicinity of our new North cades National Park. Here, the .git River drainage alone holds ut 270 glaciers.

Oregon

outh of the Columbia River ge, in Oregon and northern Cali- ia, the Cascade Mountains are er and more rolling, and while snowfall remains high, the sum- s are less humid and cloudy than are in the state of Washington. sequently, about the only place iers can exist in the southern Cas- es is on the high volcanoes—nt Hood (11.245 feet), Mount rson (10,495 feet), and Three rs (10,354 feet) in Oregon, and Mount Shasta (14,162 feet) in fornia.

regon's volcanoes have about 38 iers, covering eight square miles. state is fourth in glacial area in West following Washington. ming, and Montana. In addition, ,000- to 10,000-foot peaks of the owa Mountains in northeastern gon have several small bodies of which apparently are the remains rlier glaciers. According to natu- t Weldon Heald, a small ice field vn as Sholes Glacier clung to 5-foot Mount McLoughlin in hwestern Oregon until the sun- finally decimated it early in the 's.

California

cept for the ice fields on Mount ta, there were no known glaciers alifornia until a crisp October in 1871 when John Muir, roam- lone in the Sierra Nevada sev- days away from camp, discov- the Black Mountain Glacier in is now the vicinity of Yosemite nal Park. Despite California's erly latitude and long, sunny ers, the state holds about 80 glaciers, including the south- ost in North America. The est concentration of California ers is found near the northern dary of Kings Canyon National in the heart of the high and rug- ierra Nevada Range. Most of the ice here occurs above 12,000 nd is sheltered by the towering te walls of the High Sierra.

e Palisade Glacier at latitude 37 degrees N. is by far the largest in the Sierra (half a square mile) and also the southernmost in the United States. It rests between 12,075 feet and 13,200 feet in a north-facing cirque enclosed by protective walls on three sides. The peaks above it are more than 14,000 feet high, and the glacier is complete with a massive bergschrund, large crevasses, well-developed glacier tables—boulders sitting on pillars of ice, which they shaded while the sun melted the surface ice around them—and a 50-foot-high, sinuous terminal moraine.

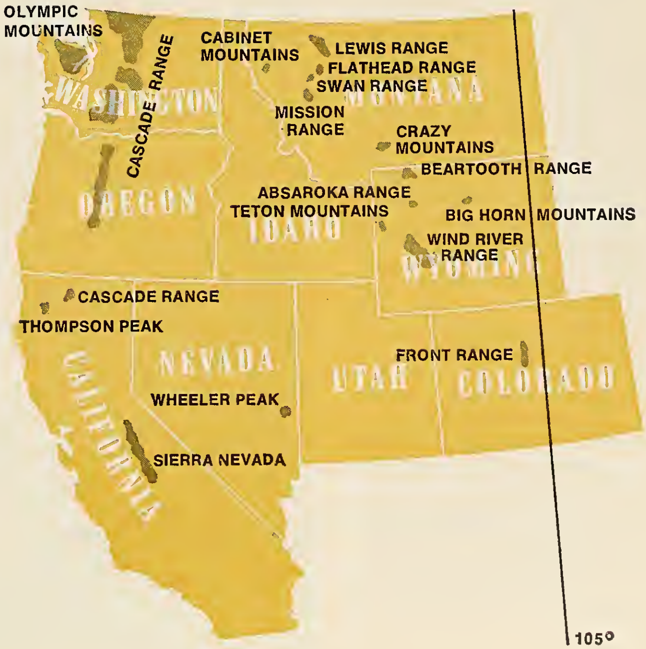
The moraine dams a frozen pond, and as the outlet water seeps beneath this rock debris it tumbles into a chain of three dazzling cirque lakes. The lake water is an aquamarine color due to suspended glacial rock flour. Such chain lakes below a glacier rest in bedrock depressions that the ice field excavated before it retreated into the shady recesses of the highest cirque. Runoff from the Palisades Glacier eventually tumbles 8,000 feet down into the Owens Valley desert, a few miles to the east, and is captured for use by suburbanites in the Los Angeles aqueduct.

In addition to the 70 glaciers of the Sierra Nevada, there are two small but active glaciers in the Salmon-Trinity Alps, which loom up behind the fog-enshrouded redwood coast in the northwest corner of the state. The highest summit, Thompson Peak, which is covered with a smattering of stunted trees, contains these two bodies of ice on its north slope, at an elevation of 8,500 feet. Heavy winter snows and relatively cool and humid summers probably account for this pair of low-altitude California ice fields.

Montana

In the Rockies there are almost 200 glaciers including some small ones located in rugged cirques below timberline at an altitude of 7,000 feet in Glacier National Park and within the Cabinet Mountains of northwestern Montana.

This section of the northern Rockies lies in the track that North Pacific storm systems typically follow on their trip eastward across the continent. These maritime storms dissipate themselves by dumping much of their moisture on the peaks of northwestern Montana; consequently precipitation in these moun-



tains may approach that recorded in the mountains closer to the Pacific coast. It far surpasses amounts received by any other inland area of the United States. A storage gauge in Glacier National Park, for example, has collected an 11-year mean of 147 inches of annual precipitation.

Dr. Meier has estimated that there are 53 glaciers in Glacier Park, covering about five square miles of terrain. The topographical map of the park, drawn up in 1900-1904, indicates a glacier-covered area about three times larger than at present. Although a marked retreat of Glacier Park's ice fields has been documented since the park was established in 1910, it is probable that the original map exaggerated the true area covered by glaciers. However, the amazingly precipitous cirques and matterhorn peaks, abundant waterfalls and chain lakes still attest to the appropriateness of the name "Glacier National Park."

A handful of other small glaciers are scattered about the Rockies of western Montana. However, the state's only concentration of alpine-zone glaciers (located above timberline) occurs in the single area where there is extensive high-altitude terrain—the Beartooth Range, northeast of Yellowstone Park. The glaciers here have an average elevation of about 10,800 feet, roughly 1,000 feet above timberline. U.S. Highway 212 winds its way up to almost 11,000 feet as it crosses the Beartooth Plateau near the Montana–Wyoming border, within a few miles of some of Beartooth's 40-odd glaciers.

The largest, most accessible, and most famous of these ice fields is Grasshopper Glacier, which in summer can be reached by a two-mile hike over alpine tundra. This mile-long glacier is a cold-storage tomb that encases a vast horde of grasshoppers, which were apparently trapped by a summer snowstorm as they either attempted to migrate over the Beartooth Plateau or were wind-blown into the area from a distant migratory route. There are so many of these frozen insects that on a warm day in late summer, thawing grasshopper corpses are apt to create a stench that carries a quarter of a mile, and a variety of alpine birds can be seen gorging themselves on this food cache.

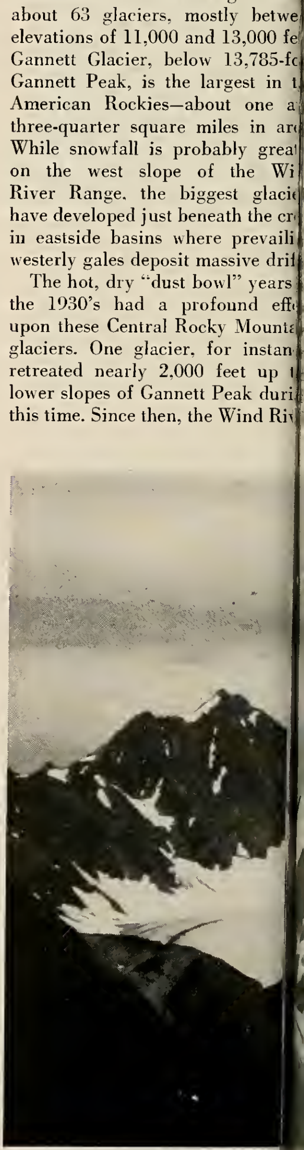
Several glaciers in this general region have grasshoppers in them, including another "Grasshopper Glacier" in the Crazy Mountains of south central Montana; but it was not until 1953 that entomologist A. B. Gurney of the Department of Agriculture traced a migration of Rocky Mountain grasshoppers from northern Nevada through southern Idaho and over the Beartooth Range. Apparently cold air over the Beartooth causes the grasshoppers to fold up their wings and plummet to earth where they are then covered by winter snows and become encased within the glaciers. Before the advent of radiocarbon dating in the 1940's, it was thought that the grasshoppers might have been captured within the ice many thousands of years ago, but the dating process now reveals that some insects deep within the glacier are no more than 300 years old. The recent sighting of these insects in glacial areas indicates that grasshoppers may be regularly encased within glaciers during periodic migrations.

Gurney cites another instance of frozen grasshoppers in "Hallet's Glacier," north of Longs Peak in Rocky Mountain National Park, Colorado. During the drought year of 1934, large deposits of grasshoppers melted from the ice, and bears fed on the refrigerated insects for several years thereafter. A pioneer resident explained the source of the grasshoppers as part of an 1876 migration that flew up from the plains and perished in the alpine heights. And late in the summer of 1868, Major John Wesley Powell's party encountered frozen grasshoppers on the St. Vrain ice fields, Colorado. The dead insects were so abundant they "literally could have been gathered in wagon-loads," according to the Major.

WYOMING

Surprisingly, there are more glaciers in the Rockies south of Montana than north of that state. In fact Wyoming, with over 80 glaciers covering almost twenty square miles, is (a distant) second only to Washington in area of current glaciation. Wyoming's glaciers are found within the magnificent Tetons, in the Absarok
and Big Horn Mountains, and in t
Wind River Range. This last ran
has the seven largest ice fields of t
American Rockies and its total gl
cial area is one and a half times
great as all other Rocky Mounta
glaciers combined. The Wind Rive
icy backbone of peaks forms the Co
tinental Divide in west central Wy
ming. The lofty cirques and vall
headwaters of this range harb
about 63 glaciers, mostly betwe
elevations of 11,000 and 13,000 fe
Gannett Glacier, below 13,785-fo
Gannett Peak, is the largest in t
American Rockies—about one a
three-quarter square miles in ar
While snowfall is probably grea
on the west slope of the Wi
River Range, the biggest glaci
have developed just beneath the cr
in eastside basins where prevaili
westerly gales deposit massive dri

The hot, dry "dust bowl" years
the 1930's had a profound eff
upon these Central Rocky Mount
glaciers. One glacier, for instan
retreated nearly 2,000 feet up t
lower slopes of Gannett Peak duri
this time. Since then, the Wind Ri



iers have retreated little, if any. everal factors probably account the extensive glaciation in the nd River Range. The high eleva- and rugged topography is un- aled in the Rockies except in orado. And according to U.S. ather Bureau estimates, this range ives more precipitation and has htly colder temperatures than orado ranges of comparable ele- on. A few high peaks of the ns compare in altitude to those Vind River, but these do not con- the big, sheltered, snow-catch ns at elevations of 12,000 feet are found in the massive Wind r Range.

COLORADO

here are only about ten glaciers he Rockies south of the Wind r Range. These occur in the nt Range of north central Colo- and comprise a total area of about two-thirds of a square . These glaciers are located at age elevations of 12,500 feet, the est in the United States. About of these lofty ice fields are found ocky Mountain National Park, and Park Naturalist Glenn Gallison says that studies of the Andrews and Tyndall glaciers show that they are dependent on wind-drifting for an adequate supply of snow.

The city of Boulder claims the largest and southernmost of Colorado's glaciers as part of its municipal watershed. This 70-acre ice field is called Arapaho Glacier, and is nestled beneath the north wall of Arapaho Peak at 12,100 to 13,200 feet on the east slope of the Continental Divide.

NEVADA

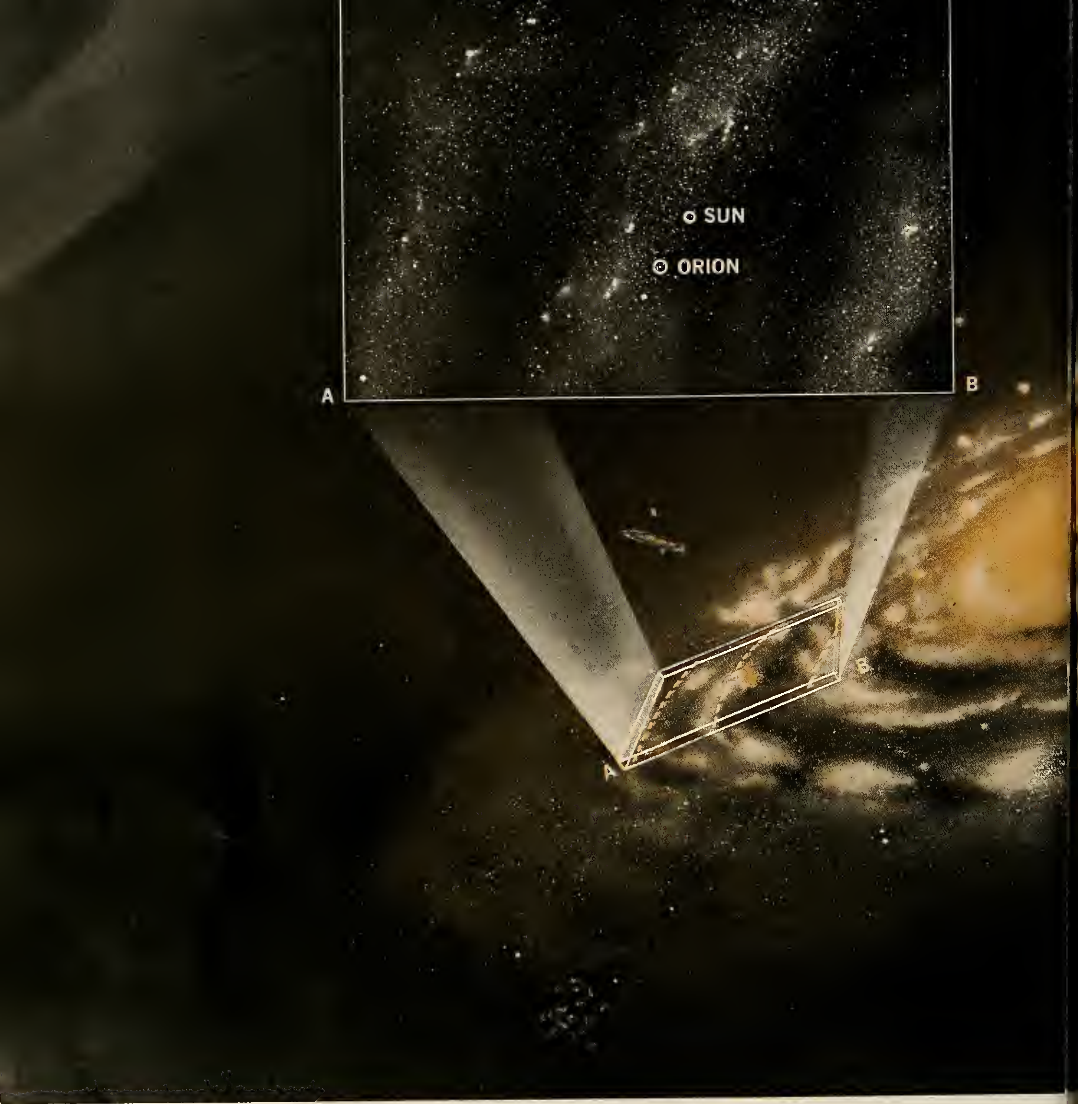
Only one American glacier is known outside the Pacific Coast Ranges and the Rockies. It occurs in a most unlikely region—the arid Great Basin of eastern Nevada, in the Snake Range. This unique desert ice field rests high up on 13,061-foot Wheeler Peak, not far from the spot where a 4,900-year-old bristlecone pine was recently discovered.

Naturalist Weldon Heald rediscovered the glacier in 1955, after having read an 1884 U.S. Geological Survey description of a body of ice on that mountain. The Survey's account stated that "A region more unfavorable for the formation of glaciers could scarcely be found. . . ." Nevertheless, the glacier occupies a deep cirque with walls so high that they obstruct views into it from almost any point outside. Heald found that the glacier has a bergschrund, crevasses, and a moraine, which is now being created.

Our basic knowledge of the glaciers in our western states is sketchy. For instance, it is possible that Idaho has a glacier or two and Utah's Wasatch Mountains have a popular attraction known as the "Timp Glacier," over which thousands of sightseers have hiked. However, the U.S. Forest Service, which administers the area, states that this snow mass on 12,008-foot Mount Timpanogos "is not ice but is a persistent snowfield." It is also possible that there are glaciers in other locations, which our limited research has not yet disclosed.

The glaciers in the American West do not match those of Alaska or the Alps in size. Nevertheless, they are as splendid as the land itself and they add another element of diversity to our environment.

A glacier's weight exerts pressure on the lower layers of glacial ice, causing them to "flow" somewhat like pancake batter, sculpturing the underlying bedrock. Fed by the snowfields above, the most active ice in Washington's Blue Glacier flows a few hundred feet each year. The glacier has a maximum thickness of 900 feet and a length of 2.6 miles.



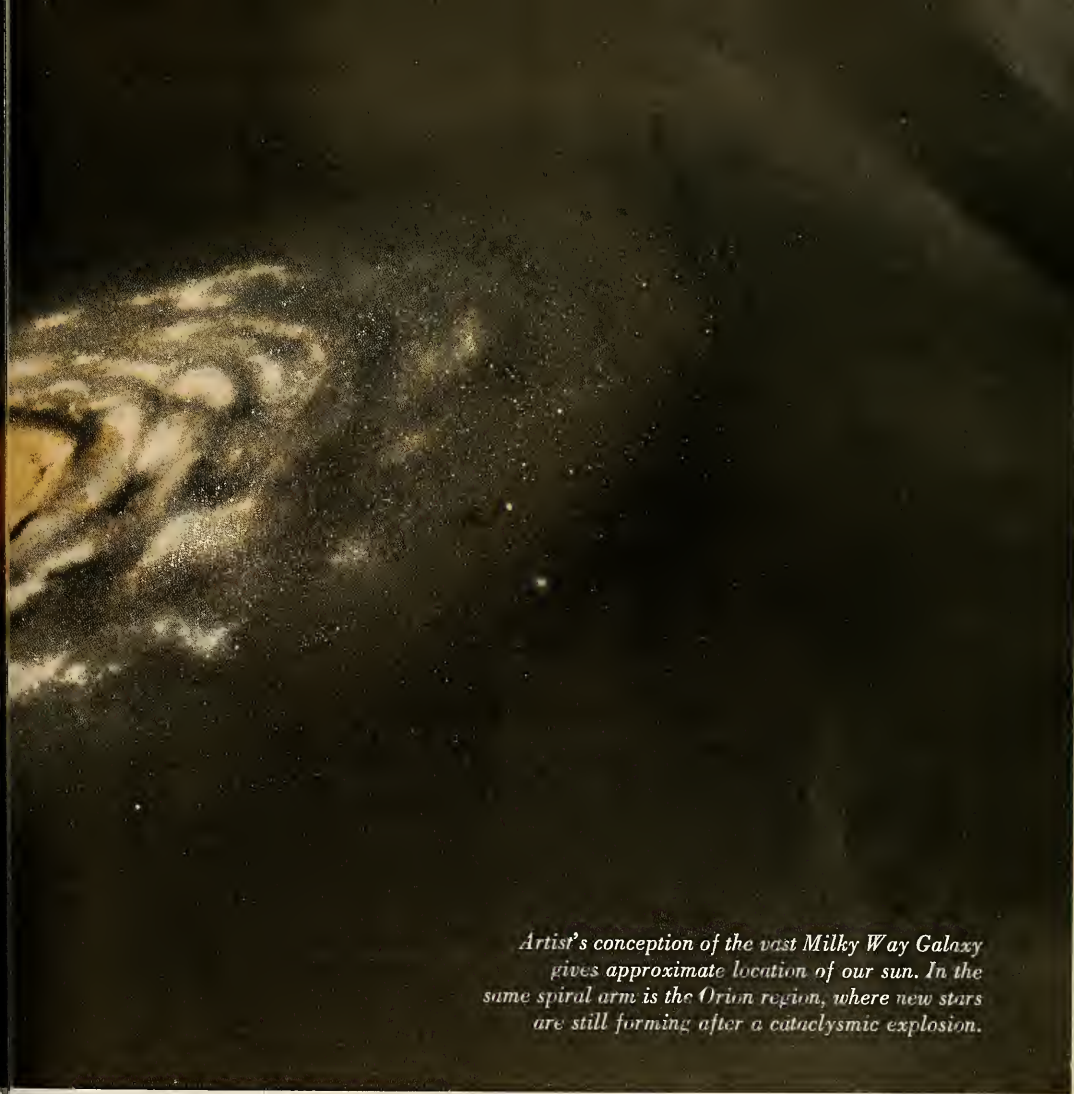
Action at Orion

From great cataclysms in the cosmos comes material that makes new stars. Orion, the Hunter demonstrates such constructive eruption

by William K. Hartmann

Not too far from our sun—actual
a million billion miles away, b
not far in terms of the size of o
Galaxy—there was a tremendous e
plosion two or three million yea
ago. The site was a spot near t
sword of the constellation Orion.
was the kind of cataclysm that c
mologists believe furnishes materi
for the star-making process.

Enough gas to make ten tho
sand or more new stars was involve
Furthermore, already existing sta
seem to have been blasted out of t



Artist's conception of the vast Milky Way Galaxy gives approximate location of our sun. In the same spiral arm is the Orion region, where new stars are still forming after a cataclysmic explosion.

gion; they are seen drifting across
r part of the Galaxy. Of course, the
ift of stars is too slow to be visible;
t it can be detected by studying
otographs. If we could speed up
r vision, the "runaway stars"
uld look like a shower of sparks
m a cosmic skyrocket display.
ese "sparks," mostly faint, incon-
cuous stars, extend over a sub-
ntial part of the sky on winter
enings.

In cosmic terms, the explosion in
ion was not extraordinary; it was only one of the many that have happened in our Galaxy, in fact in our own neighborhood. Concerning our neighborhood, remember that we live on one of the many majestic spiral arms that arc around the center of our spiral Galaxy, the Milky Way. Inasmuch as all of the curved arms lie in the same plane as, but at different distances from, the center, our Galaxy has the shape of a large disk. In this disk our solar system is a microscopic speck. The illustration above locates our solar system near Orion—on the inner edge of one arm and out toward the rim of the disk itself.

This disk is so thin and flat that if, standing on the earth, we look out through the disk's "top" or "bottom," we see only the few scattered stars that lie close to us. But if we look along the plane of the disk, especially toward the center, through that pattern of curving arms, we see myriads of stars. Most of them are so distant that they blend together into a hazy band of light, hence Milky Way. Superimposed on this band are huge, obscuring clouds made up of grains of dust. It is because these dust clouds blot out some of the distant stars that we see the otherwise milky uniformity of the Milky Way broken by dark lanes and patches.

The most spectacular view of all—the one that shows the most stars—results from looking right down the spiral arm on which we live. This is what we do when we look toward our neighbor Orion.

Step outside on a clear winter or spring evening when Orion is easy to see. (Orion is shown on the monthly Star Map, page 79.) Swing your head around; scan the sky. You will quickly see that there is a tremendous concentration of bright stars and close groupings of smaller stars that accompany Orion. Among these are Sirius and the Pleiades.

To understand what our eyes see, and what the explosion in Orion may have been, we should realize that our Galaxy is not dead. Ponderously turning, it is also undergoing many changes. The sun makes a complete trip all the way around the Galaxy every few hundred million years, but the inner regions are rotating faster. This produces a kind of tearing effect. Throughout the Galaxy any temporary grouping of stars eventually gets sheared apart. Each tends to leave its pack. Also, interactions among stars in any grouping may cause certain stars to be ejected.

Among the stars of the Galaxy, it is the large ones that squander their nuclear energy at a prodigious rate, die, and wink out in only a few million years. Smaller ones, like our sun, live for billions of years. Some are even as old as the Galaxy itself (something like ten billion years).

Meanwhile, as older stars drift away from each other and die, new ones are continually forming out of the dust and gas concentrated in the Galaxy's arms. A simple proof of this fact is the very existence of star clusters, such as the several hundred stars that constitute the Pleiades. This group lies to the right of Orion (as seen by observers in the Northern Hemisphere), and is only about one-fourth as far from earth. Studies on the rate of breakup show that such close groupings cannot last more than a few hundred million years—yet there they are. The only sensible explanation is that they must have formed relatively recently—recently, that is, in terms of the Galaxy's age.

Such star clusters play another important role in our conception of what is happening. Investigations have shown that the density of gas and dust in the interstellar regions, even within the spiral arms, is so low that it severely restricts the star-making process. Only tremendous masses of gas and dust, sufficient to make hundreds of stars, possess enough of a gravity field to account for the necessary sequence: the masses of gas begin to contract; they fall in upon themselves: and then break up into individual balls of gas—namely, stars. Therefore, the regions of most activity will be in the spiral arms, where there are concentrations of enough gas and dust to form clusters of stars.

This is where observing Orion contributes much to our understanding. Few people realize that we on earth have a grandstand seat in our Galaxy for watching the fantastic results of these processes. Orion, just down the spiral arm from us, is a hotbed of star-forming activity.

Last winter I strapped an ordinary 35 mm. camera to the side of a hand-guided telescope. Then I made a series of photographs, which, mounted together in a mosaic, demonstrates some of the interesting features of this part of the sky.

In the background is the Milky Way. One sees it stretched across the top of the scene, mottled by its characteristic, scattered dust clouds. Note the brightest stars of the region. Seen in perspective from earth, they mark out the figure of Orion—the mighty hunter known to man for several thousand years as a familiar celestial friend.

His shoulders and knees are marked by four bright stars. His right hand holds a club and arcs up over his head. (I have heard Irishmen claim that the constellation is really "O'Ryan and his shillelagh.") He wears a tight belt delineated by three stars, and from it hangs a short sword—apparently three more stars. However, the rather fuzzy "star" in the sword's center is not really a sta but a huge cloud of hydrogen gas. This is the famous Orion Nebula which the naked eye sees only as fuzzy patch. Its true and beautifu complexity of glowing colors ar shown on page 32 of the January 1968, issue of NATURAL HISTORY.

It is in that nebula that stars ar being born right now. For instance a small telescope is sufficient to reveal the Trapezium—four youn stars clustered in the center of th nebula. It is estimated that this complex began forming only ten thousand years ago, at about the time tha man reached the stage of agricultur and village life.

The Orion Nebula glows becaus

Photomontage places Orion in relation to other astral regions visible "down our spiral arm."

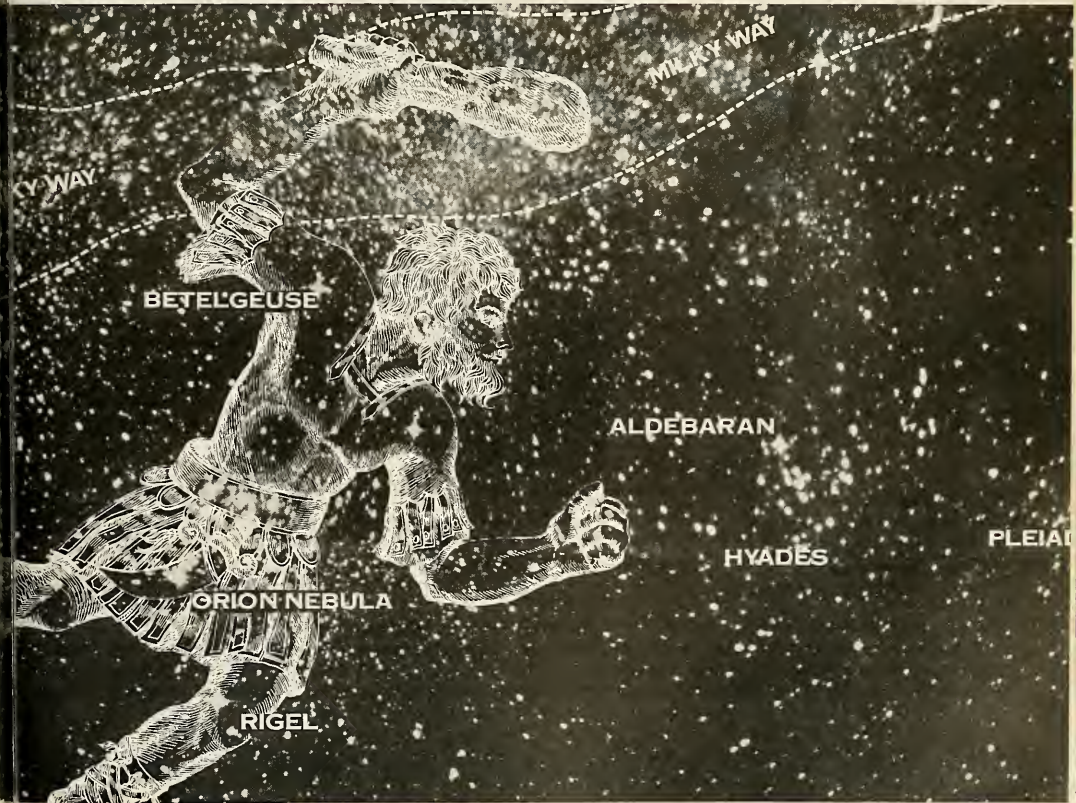
ltraviolet radiation is flooding it om the young stars within and earby it. The amount of gas in it estimated to total a few thousand mes the mass of our sun. It is imortant to note that the entire nebula expanding, apparently driven outard by radiation and heat from the ars embedded within it.

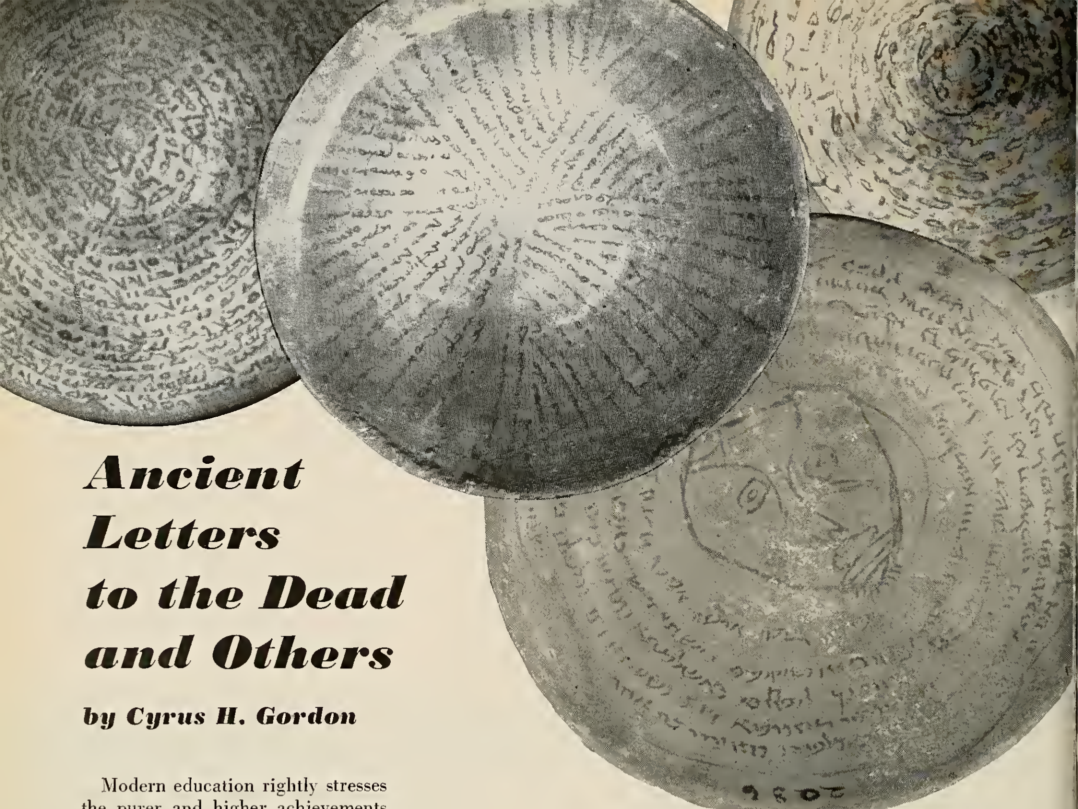
The tremendous explosion in rion two or three million years ago oduced the same kind of expanon. but on a larger scale. It, too, me from the sword of the hunter. ebris from this explosion includes huge arc of hydrogen that curves ong the left edge of the constellaon. It is not visible to the naked e, but was discovered on photoaphs in 1895 and is named Barrd's Loop Nebula after its disverer. In addition, runaway stars ve been located in various parts the sky, and their motions indicate they departed radially from the Orion area, from a point near the top of the sword, not far from the Orion Nebula. It was by tracing back to the origin that the time of the explosion has been estimated. All the evidence suggests a spectacular prehistoric period of star formation. Apparently a violent expansion followed this period millions of years ago.

To the left of Orion, on a line along the belt, is Sirius. Because it is a hot, blue star, one of the large stars that lasts only a short time, we conclude that it is relatively young. Sirius is virtually right on top of us—less than one per cent of the distance to Orion.

To the right are two prominent star clusters that formed some millions of years ago on the inner part of our spiral arm, not far from the sun. First is the Hyades, on the order of a tenth as far away as the Orion complex. It forms a V, with the bright red star Aldebaran at one tip. Farther to the right lie the Pleiades—the familiar cluster known as the "seven sisters." It contains many more than seven stars, of course, but only six or seven are bright enough to be seen by the naked eye. All of these are hot, blue stars, each surrounded by a wispy nebula of dust and gas that was left over from its formation (the nebulae can be seen only on long exposures made with astronomical telescopes). Gradually these two clusters will disperse, adding their present numbers to the stars scattered through the sky at random—of which the sun is one.

From Sirius to the Pleiades, the panorama of activity in our part of the Milky Way Galaxy stretches across our southern skies. Step out on a clear winter evening and look at it. It qualifies as one of the greatest shows off earth.





Ancient Letters to the Dead and Others

by Cyrus H. Gordon

Modern education rightly stresses the purer and higher achievements of mankind. But as a result we often come out thinking that every other Greek was a philosopher and every other Hebrew a prophet. The plain fact is that most members of even the most creative ancient societies were ordinary people trying to get along from day to day in a troubled world.

The ancient Egyptians learned how to build pyramids and how to set broken bones, for the Nile Valley nurtured both scientific engineers and surgeons at an early date; they did not, however, develop a science for overcoming hostility, unhappiness, and trouble. They dealt with such problems through techniques that we do not regard as rational, but brand as magic. Yet these techniques, which were used to achieve well-being and peace of mind, were successful enough to endure for hundreds and, in some cases, thousands of years. Magic was not a waste of time in Pharaonic Egypt; it had practical aims and helped people get on with the business of life.

One intriguing kind of Egyptian literature is known as "letters to the dead." The Egyptians believed that the spirits of the deceased continued to influence the destinies of the living, and therefore wrote letters urging the dead to take action on the writer's behalf and to desist from harming or neglecting him. Written in the third and second millennia B.C., most of these letters were inscribed on bowls by hired magicians. With the movement of peoples across the Mediterranean, and overland in Asia, this practice reached Crete and Babylonia. The writing of magical texts on bowls lasted in Babylonia for three thousand years after it began in Egypt.

It is instructive to compare modern American "letters to the dead" with ancient Egyptian ones. Modern versions can be found often enough in the "In Memoriam" column on the obituary page of the *The New York Times*. They inform the deceased (in the second person!) of the writer's remembrance and devotion, and may take a form such as this: "Doe, John: We remember you lovingly on this, the third anniversary of your departure. You are always in our hearts. Mary and children." Taken at its face value, such a message is designed to maintain contact with the dead and express the writer's feelings.

The Egyptians were less sentimental than Americans. They never expended time or energy on writing to the dead simply to keep up some vague contact or express feelings of tenderness. They wrote to solicit practical help in solving legal, medical, and psychic problems. They posted the letters by placing the inscribed bowls in tombs, where the spirits of the dead could find them.

The letter on the "Cairo Bowl" (the bowls are named after the places where they were found or are now kept) is written on behalf of a widow who reminds the spirit of her late husband that she has been looking after his household and taking care of his personal needs by pouring water for him. Yet she finds it necessary to chide him: "You are not fighting for her [the writer] night and day against every man and woman

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gram in opposite column. Below are details
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r scenery and thrilling nature experiences. In
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opposite column for dates, and by, all means
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— SOUTH AMERICA —

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ek tours circling South America, starting Aug.
in Colombia and swinging counter-clockwise
und the continent. We'll go as far south as
rra del Fuego, touch all the famous bird ob-
vation highlights of the Andes and both coasts,
l end in Venezuela before Xmas. See dates in
osite column, and let us send you the itinera-

— EUROPE —

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en separate tours is by far the broadest view
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nery ever offered. Take single excursion trips
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ks.

OPE SOUTH covers France's Camargue and
Riviera, Switzerland's birds and alpine flora,
amed Neusiedlersee on the Hungary border,
nd the Rhine country; May 8. **EUROPE NORTH**
akes in northern Germany and covers Sweden
ully to and beyond the Arctic Circle; May 29.
ORWAY. our most popular of all, covers
jords, mountains and coastal islands in an
tinerary that has become famous; June 22.
These 3 tours combine into a memorable jour-
ney "north with the spring" from the Mediter-
anean to North Cape and the Arctic.

DITERRANEAN begins at Lisbon, visits Spain's
amed Coto Doñana, France's Camargue, Cor-
ica and northern Italy; May 8. **BALKANS** starts
t Venice, visiting bird and botanical high-
ights of Yugoslavia, Greece, Turkey, Romania
nd Hungary; May 29. **U.S.S.R.** starts from
Prague June 22, covers natural history high-
ights of Poland and Russia. **SIBERIA** is a 3-wk.
ink in an economical round-the-world route;
he Asian U.S.S.R. republics, Lake Baikal and
journey into Outer Mongolia are features;
uly 13. These 4 tours combine into an extra-
rdinary nature experience.

TAIN, leaving May 29, is a popular broad
overage from southeast coast to north tip of
Scotland. **ICELAND**, 2-week visit to this weird
country, offers a choice of departures (June 28
r July 21), with a new 10-day camping trip
cross little-visited centre and east coast areas
vailable between the tours, and a visit to
Greenland optional at the end.

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und-the-world experience stretching be-
veen Christmas and Easter.

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who is injuring her. Why do you want your house ruined?" She then exhorts him: "Fight for her! Watch over her! Save her from all the men and women who are injuring her! Then shall your house and your children be established."

The writer may take a more mild and deferential attitude toward the dead. In the "Berlin Bowl" a widower reminds his deceased wife that in this world she never had a grievance against him, and yet there are wounds that are being inflicted with or without her knowledge. He begs her, if there has been any offense, to forget it for the sake of her children. The letter ends with the prayer that she be gracious so that the gods may be gracious to her. The text is on the inside surface; in the center is the bust portrait of a woman, apparently representing the addressee.

The "Chicago Jar Stand" bears a letter by a son to his dead father asking for help in getting a healthy male child; a postscript requests another healthy male child for "your daughter" [the writer's sister]. The writer also begs his dead father to foil the machinations of two servant maids who are afflicting his wife. Whether the maids were among the living or dead is not stated. The jar stand has an upper rim but is bottomless. By itself the stand could not contain an offering, although it could support a bowl with an offering. This is of interest because of the theory that the inscribed bowls contained food to attract the dead, who then could not help seeing the letters. The jar stand suggests that the ceramics on which the letters were written were in any event part of the tomb furnishings, although not necessarily receptacles for food. Food might have been used as bait on occasion, but this was not necessary to attract the attention of the dead to the document.

About 2500 B.C., a little before the earliest known letters to the dead, Egyptian enterprise penetrated the Aegean. A thousand years later, while the Egyptians were still writing incantations on bowls, the practice had also spread to Crete. During the first six Christian centuries it reached its height in Babylonia, where the largest number of magic bowls have been found. The Semites who carried Egyptian culture from the Nile Delta, across the Mediterranean, and into Asia expressed it in their own dia-

Overseas Nature Tours

— 1969 Program —

Here is a summary of our 1969 program. Space permits only brief mention of each tour, and one should, by all means, have the "Tour Catalog" with thumb-nail sketches of each trip. Early registration will save disappointment, and may be made tentatively. North America tours 2 wks., remainder of the world 3 weeks each, except as otherwise noted.

— NORTH AMERICA —

FLORIDA: Wild portions of the State from Tallahassee to Key West. Jan. 11.

TEXAS BIRDS: Whooping cranes, Rio Grande reserves, Northeast Mexico. March 15.

TEXAS WILDFLOWERS: Separate wildflower group on above route. March 15.

ARIZONA: Popular bird tour of southeast Arizona under Dr. Robert Ohmart of University of Arizona. April 26.

CALIFORNIA: North-with-spring in parks, mtns. & off-coast islands. May 10 (3 wks.)

CASCADES: North through Oregon and Washington reserves and parks. May 31 (3 weeks.)

ALASKA: Three successive 2-wk. trips: (1) The inside passage and Yukon; (2) the central region with McKinley Park, Kenai, Kodiak and Katmai; and (3) outposts of the Aleutians, Pribilofs, Nome, St. Lawrence . . . Island, Kotzebue and Point Barrow. Series begins at Seattle June 21.

Note that the last 5 tours may be taken in continuous succession, following spring north in one great 12-week trek from the Mexico border to Point Barrow on the Arctic.

— MIDDLE AMERICA —

CENTRAL AMERICA: Feb. 8-14. Guatemala, Salvador, Honduras and Nicaragua. Tropical birdlife and botanical highlights.

COSTA RICA: Feb. 15-28. Itinerary carefully examines in sequence the five faunal regions.

Note that Yucatan, Panama and Colombia are done twice a year in a continuous chain, affording a 7-week view of the bird and plant life of tropical America that is both memorable and economical. In 1969 this series starts Jan. 11 and July 19.

— SOUTH AMERICA —

COLOMBIA: World's top bird country. Two 1969 departures: March 15; Aug. 16.

ECUADOR-PERU: Heavy bird populations of jungles & high Andes, including Machu Picchu and upper Amazon. Sept. 6.

CHILE-ARGENTINA: Highlights of both coasts, plus Tierra del Fuego. Sept. 27.

BRAZIL: Iguasu Falls, the Rio coast, central jungles and the Amazon. Oct. 18.

GUIANAS-VENEZUELA: The 3 Guianas, Trinidad and highlights of Venezuela. Nov. 8.

The 5 South America tours, starting with Colombia on Aug. 16, readily combine into a remarkable grand tour of the continent.

— EUROPE —

By all means obtain the detailed announcement of our 11-tour 1969 Europe program, with its many possible combinations. See opposite column for additional information.

— AFRICA, ASIA, ETC. —

SOUTH AFRICA: This popular trip departs July 24, includes S.W. Africa and the Kalahari.

EAST AFRICA: Extremely heavy bird concentrations, many big mammals. August 14.

CENT. AFRICA-MADAGASCAR: New and promising, beginning at Victoria Falls Sept. 4.

JAPAN: Full-time birding from south tip of Kyushu to north end of Hokkaido. Optional extra week for tourist objectives. Aug. 2.

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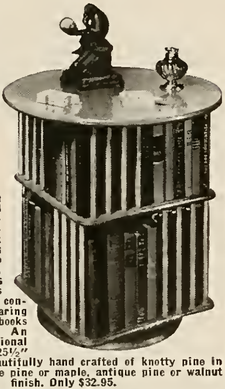

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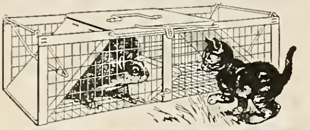

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lects. Thus the earliest inscribed magic bowls found outside of Egypt come from Crete, and yet, the inscriptions are Semitic.

The Babylonian magic bowls are inscribed in a variety of dialects of Aramaic, a Semitic language; they date from about A.D. 200 to A.D. 600. The commonest dialect, Jewish Aramaic, resembles the speech of the Babylonian Talmud, which comes from about the same period. The Jews became a nation in Egypt's delta area before conquering their Promised Land. In biblical times, magic was outlawed in Israel. Yet we know from incidents such as the Witch of Endor (1 Samuel 28) that it existed *sub rosa.* When the Hebrew commonwealth came to an end, and there were no kings to enforce the prohibition of magic, it emerged into the open as we can see in the Talmud and New Testament.

How much Egyptian magic the Jews of Babylon had remembered since the days of the Exodus is questionable. However, another people in Talmudic Babylonia, who also left us many magic bowls, had more recent Egyptian ties: the Mandeans, who still linger on as a dwindling minority in Iraq and Iran. They revere two angelic personages with Egypto-Semitic names: Ptah-il, "Ptah-is-God," and P-re-il, "Re-is-God" (while *il,* "god," is Semitic, Ptah and Re are Egyptian deities). The Mandeans reckon with the soul of men in the form of a bird and call it the *ba,* exactly as the Egyptians did. The Mandean calendar, twelve months of thirty days each, plus five intercalary days, is quite Egyptian. While there are other factors in the complex origin of the Mandeans, the Egyptian component is so strong that the Mandeans may have been instrumental in introducing Egyptian-style bowl magic into Babylonia at a fairly late date. They were in Palestine about the beginning of the Christian Era and were sufficiently involved to have taken sides in important religious developments.

The Aramaic magic bowls—like most schools of magic—are interdenominational. Alongside the Mandaic and Jewish Aramaic bowls are others written in Syriac, which is associated with Near East Christianity. Many of the clients, who hired sorcerers to write the incantations, have Persian names. Zoroastrians, Jews, Mandeans, and Christians would not hesitate to go to a magician of another denomination. Magic is more "ecumenical" than religion has been over the centuries. If somebody wants to be cured or get rid of demons, what difference does the religion of the practitioner make to him? This aspect of magic renders it a important means for the transmissio of culture from group to group.

Several aspects of the Babylonia bowls remind us of the Egyptian letters to the dead. The Babylonia bowls were sometimes posted in th cemetery—an Egyptian practice—an the letters inscribed on them ma echo the Egyptian letters, thoug they by no means duplicate them Matronymic names (derived fro the name of the mother or materna ancestor) are the rule in the Babylonian bowls—contrary to norma Semitic usage—and this harks bac to the Egyptians. Drawings of huma or demonic figures on the bowls ma continue the tradition that, as I hav noted, first appeared in Egypt. Bu the very use of inscribed bowls is th main thread that connects the magi bowls of Egypt with those of Babylonia over a period of about 3.00 years (roughly 2500 B.C. to A.D. 500

The differences, however, a basic. While the general aim is th same—to protect the client and fo his foes—the methods are by n means similar. Unlike the Egyptian the Semites did not place any gre reliance on the dead. Instead the ascribed power to the magicians the employed and to gods, angels, an demons.

Clients turned to magicians f well-being and peace of mind in world that had not yet developed i surance programs. One married co ple invokes "salvation from heave to protect their home, along wi "their sons and daughters, their ox and asses, their male and fema slaves, and cattle great and sma which are in this dwelling and thres old, which are therein, and are goi to be therein, from now and foreve

The bowls are protective or c fensive; not destructive or offensi We are dealing with "white" mag not "black" magic of the voodoo v riety. Any harm that is sought against enemies who have cursed t client so that the latter seeks only return the evil back to those w have set it in motion. To cite one

ny bowls that illustrate this:
ɔund are the hands and feet of the
n and women who have worked
l against this Brikyabya son of
rat, and let all the evil spells be
·ooted from this Brikyabya son of
rat and from his constellation and
net and from all his house and
m all their dwelling, and let them
turned back and return and go to
se that worked them and to those
t sent them, from this day and for-
r, in the name of Yahweh, God of
sts. Amen, amen, selah, halle-
ıh! And it is written [in Psalm
7, 10]: 'A thousand may fall at
ır side, and ten thousand at your
ıt hand. But it will not come near
. No disaster will befall you, nor
ımity come near your tent.' " The
rturning of the enemies' curses
y have gone hand in hand with
ersion of the bowls, for an appro-
ıte magical act accompanied the
ıntation. This is a possible ex-
ıation of why bowls have been
nd upside down. (It is also pos-
e that inverting the bowl was
ved as a means of trapping the
ıon underneath.)
ınother feature of the text just
ted is the invocation of God and
use of a psalm for protection.
cially, organized religion frowns
magic, for a public that turns to
ırds, who claim to have power
· the forces of nature and over
world of spirits, may be tempted
ely less on the church or syna-
ue. However, alienation from or-
ized religion need not follow; in-
l official and popular religion
n coexist. The same person may
ere to a church or synagogue for
official religion, and carry around
bbit's foot as part of his popular
gion. Moreover, official religion
ls to be lenient toward protective,
'white,' magic, which may en-
ce one's sense of security without
ing anyone else. The citation of
blical psalm reminds us of some-
g that is not always realized: one
ıe main functions of the psalms
save the believer from the ca-
ties that beset him in this world.
he magicians also invoked sup-
from paganism. They thus called
ome old Babylonian gods to pro-
their clients' children from death,
ıe following exorcism: "O Mur-
ss, daughter of the Murderess!
out and depart. . . . The Sun has
me against you, the Moon has

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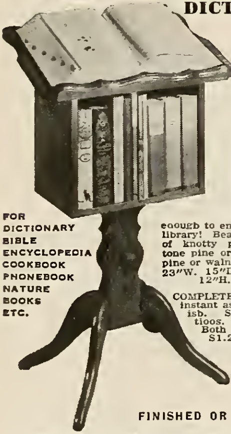
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dispatched me, Bel has commissioned me, Nanay has said to me . . . and Nergal has given me the power that I might go against the evil spirit, namely Dodib, whom they call the Strangler that kills babies in the bosom of their mother. . . . Get out from before these angels that sons may remain alive for their mothers and little children for their fathers!" The method employed is to drive out the demons through the powers invested in the sorcerer.

In general the aim of the spells had to do with day-to-day family life. Romantic themes were rare, although we have two bowls from Nippur written for a woman who invokes "the Lord of heaven and earth," "the angel Rahmiel," and the pagan goddess Dlibat (Ishtar) to make a certain man "hot, kindled and inflamed" with love for her. But there was much less concern with infatuation and passion in Babylonian society than in the modern West. People married to establish a household blessed with children and subsistence; they turned to magic to protect the family and its livelihood. Romance was not that important. To be sure there were brothels and cabarets, so several Mandaic bowls include protection "from the curse of harlot and singing girl," but in general, bowl magic reflects a family-centered society.

The main sexual irregularities reflected in the bowls are quite different from those familiar to the modern psychiatrist and social worker. The bowl clients fancied themselves endangered by lecherous demons and liliths (as the demonesses were often called) who beguiled innocent wives and husbands by impersonating their human mates. This kind of adultery terrified the ancients. A demon could impregnate a married woman with a child whose traits could disrupt family life. This approach explained actual human relations to the satisfaction of the ancients. If a son hated his father or was otherwise incorrigible, it was concluded that the child had been sired by a demon. The impregnation of a demoness by a man was also fraught with danger, because the offspring might haunt the home and hurt the children of the human mother. It became a major problem to exorcise the demons and liliths so that they could not enter the home or be on hand to seduce the human couple. A favorite way of
achieving this was through a pote
bill of divorce. Rabbinic law enable
a man to get rid of his wife simpl
by serving a divorce on her; she w
through as soon as the writ w
placed in her hands. The magicia
applied human divorce proceedin
to the demonic troublemakers—bo
inscriptions record the banishing
demons with a "bill of divorcement

A rabbi with an honored name
the main Jewish tradition. Josh
bar Perahia, plays a special role
the magic bowls. His divorce wri
were so potent that no demon
lilith could resist them. The bo
exorcisms therefore pronounce t
divorce in the name of Rabbi Josh
A peculiar, but widespread, cust
in antiquity called for expelling
reprehensible wife stark naked. O
text calls for exorcising a group
demons through Joshua's bill
divorcement with the statement t
they are forthwith expelled sta
naked and with disheveled hair.
nude female with flying hair,
arms tied and feet chained so that
can do no more harm, is drawn
the bowl to make sure that eve
means, graphic as well as verbal,
been used to rid the client of troub

Some of the Aramaic bowls app
to myths as the precedent for bani
ing evil. The myth of Leviathan
particularly widespread and po
lar. It first appears on a Babyloni
seal cylinder from about the twen
fourth century B.C., in a scene wh
virtuous heroes are slaying a sev
headed monster. In the fourtee
century B.C. the same myth turns
in the Ugaritic tablets found on
north coast of Syria. Psalm 74:13
relates how God crushed the heads
Leviathan, while Isaiah 27:1 pred
that the golden age will be ushe
in when God, the force of goodn
will kill, once and for all, Leviath
the force of evil. We are dealing h
with a cosmic myth, which tells
that in a primeval conflict the fo
of good triumphed over the force
evil, and in the end of days, the b
tle will be refought and rewon so t
evil will be banished forever.

It is important for us to und
stand that for thousands of years
kind of myth gave men the cour
to go on. Men, then as now, w
beset with troubles and dangers
is a mistake to think that the anci
regarded Leviathan as a mere sym
of evil. Until rationalism undermi

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man's faith in cosmic myths, the victory of God over Leviathan and the conviction that God would some day annihilate Leviathan (and all evil, which is summed up in that dragon) gave men strength. The ancient concept of time had it that we live in a troubled world between two cosmic events: between the primeval and the final victory of good over evil.

The Aramaic bowls invoke the primeval defeat of Leviathan as a potent threat to deter the forces of evil from harming the clients. In one of the texts the magician proclaims: "I have gone [and] confronted the evil satans and mighty foes. I say to them: 'Woe unto you if you do anything to them. . . . I am enchanting you with the great spell . . . of Leviathan the dragon. Again, if you say anything to them, I am drawing the bow against you and stretching the string against you.' " The incantation was evidently accompanied by a ritual act such as drawing a bow against the forces of evil. The magical complex included citing the myth for precedent, reciting the spell as written on the bowl, performing a ritual act, and depositing the bowl in the proper place and manner for assuring the client of permanent protection. For a public that accepted the premises, such a spell could provide as much peace of mind as men can achieve.

For thousands of years belief in demons made it possible to banish anxieties through exorcism and thus bring relief to troubled men and women. Disease, worry, and harm were viewed concretely as demons. Guilt played little or no role. Through no fault of his own, any person might be haunted or tormented by a demon. The way to prevent or cure one's troubles was simply to engage a professional exorcist to perform the rite and to inscribe, recite, and deposit the incantation, with instantaneous results. Later, if new problems arose, another incantation could be purchased.

It is doubtful whether any present method of psychic therapy will prove as lastingly effective as this form of magic proved itself during its three-thousand-year odyssey from Egypt to Babylonia.

Dr. Cyrus H. Gordon is Chairman of the Department of Mediterranean Studies at Brandeis University.

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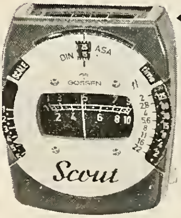

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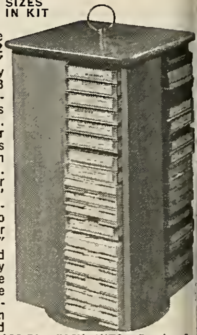
REVIEWS *Continued from page 26*

it and by means of it, the human state can be defined with all its attributes, even those like mortality which might seem the most unquestionably natural." This intellectualist conclusion about the meaning of food and food preparation does not, of course, make Lévi-Strauss' *Mythologiques* simply the anthropological version of the *Larousse Gastronomique;* but it is perhaps fitting that a French *philosophe* could rephrase the German Feuerbach's contention "Man is what he eats" to read "Man is, what he thinks he eats." Nor does this conclusion even begin to exhaust the wealth of ethnographic data and the numerous ethnological analyses presented in *The Raw and the Cooked.* Thus, Americanists will find a series of suggestive historical reconstructions based on structuralist principles, while anthropological theorists may examine a number of methodological arguments on such perennial issues as the relation between form and content, myths and their transformations, "symbolist" and "functionalist" explanations, etc. We cannot go into these questions here, but those interested will find Lévi-Strauss' book indispensable reading.

One final question should be asked, one which inheres in the very organization of *The Raw and the Cooked* (whose Table of Contents includes such musical forms as Overture, Theme and Variations, Symphony in Three Movements, etc.) and reflects on the general scope and possible limitations of structural investigations: what is the anthropological meaning of Lévi-Strauss' celebration of comparative mythology, especially given its intimate kinship to the nature and understanding of music? Both myth and music mediate man's crucial passage from nature to culture by integrating the syntactically constituted and symbolically conscious domains of his intellectual reflections and esthetic creations with the neurologically determined and unconscious silence of his physiochemical nature and bioecological constraints. In structural explanation generally, the latter invariably underlie and account for the former. In the present context this means that mythology and music—profoundly important as they are—can do no more than "bring man face to face with potential objects of which only the shadows are actualized, with conscious approximations . . . of inevitable unconscious truths." In other words, behind the joyful and creative enactment of mythic literature or the encompassing and self-reflective composition of musical forms looms the more determinist and quite mechanical reality of a cybernetic and esthetically indifferent unconscious. If structural investigation is to understand and explicate the implicit workings of this unconscious



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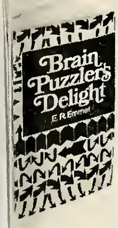

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and universal brain, it must of necessity become the silent listener to the rhythms and pulsations of that unconscious; it can no longer hope to speak explicitly about the human condition or man's cultural products. That is, if Lévi-Strauss is to remain consistent with his own stated premises, structuralism is either reduced to inexplicable silence, like a concert audience, or to artistic metaphor, like the poet-musician. In the final analysis, the intellectually reflective and scientifically deliberate study of the infrastructural and hidden unconscious reality of myth "is itself a kind of myth."
[*The Raw and the Cooked* will be published May 7, 1969.]

Bob Scholte is an instructor of anthropology at the University of California, Santa Cruz. He recently completed a dissertation on structuralism.

MY BEAVER COLONY, by Lars Wilson. *Doubleday & Co., $4.95; 154 pp., illus.*
CAPTIVE WILD, by Lois Crisler. *Harper & Row, $5.95; 238 pp., illus.*

Midway between the zoo and the wilderness there should be a place where animals can be studied more or less objectively, and now and then someone tries to create such a place. Here are two books about wild animals living in what may be called permissive captivity, and two more different reports can scarcely be imagined. Lars Wilson's book is about beavers in Sweden. Lois Crisler's book is about Alaskan tundra wolves in Colorado. One is a fond but relatively dispassionate report. The other is a love story and passionately emotional.

Lars Wilson admired beavers, and when a hydroelectric project began tinkering with the water level in a river near his home, he saw that the beaver colonies there were in serious trouble. With the help of a forester who also was interested in the beavers, Wilson livetrapped a number of young beavers, established a colony of his own, and began studying them. The colony was in what Wilson calls "a stream aquarium" at a salmon hatchery, as near to natural conditions as could be managed.

Perhaps half of Wilson's book is given over to his report on beaver habits and ways of life. He seems to think that much of what he learned is new, and perhaps it is in Europe. But virtually everything he learned has been known in this country for some years and was summarized by Leonard Lee Rue III in 1964 in his beaver volume of the "Living World" series. Similarly, Wilson's photographs are good but no better than Rue's and not so

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encompassing of the subject by a considerable margin.

Lois Crisler's book tells how she and her husband, after their photographic assignment in the Arctic, brought home to Colorado five young tundra wolves they had raised. Among them was Alatna, a bitch for whom Mrs. Crisler had a deep, abiding love. The bulk of the book is about Alatna and Lois Crisler, who seemed willing to sacrifice anything for the wolf.

The wolves were kept in big pens with enough natural features, trees and rocks, to simulate the wild. The pens and cabin were in the mountains about 50 miles west of Colorado Springs. The wolves escaped from time to time, and finally four of them, all but Alatna, were killed on one foray. Outsiders who saw wolves threatening their herds didn't hesitate to shoot, a fact that Mrs. Crisler seems to resent bitterly, although she tells how unpredictable the wolves were, sometimes to a point where not even the Crislers dared enter the pens.

After the other four were killed, attention centered on Alatna. She was mated to a part-wolf dog, and she h three litters of wolf-dog pups over t years. Some of the pups were so vicio they had to be shot out of hand, so escaped and were killed, some w drugged to death simply because th were too many of them, and some w killed by the older wolf-dogs. T whole story becomes a grim recital bloody meat and dead wolf-dogs, in t midst of which the Lois–Alatna l affair becomes more and more obs sive. The book adds relatively little knowledge about wolves, in or out captivity. And it ends in a macal scene. Lois goes to talk things o with her husband, who was workin mine to make a living and maintai home for the animals. They talk "personal matters that cannot be solved," and she decides this means cabin and the wolf-dog pens will h to be given up. Facing what she say friend called "the Medea decision,"

Lois Crisler and her wolf share an affectionate moment before the relationship came to its violent end. From "Captive Wild.

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goes home, gives a lethal dose of "euthanizing pills" to every animal on the place, then finishes the job with a gun to make sure death is quick, especially for Alatna.

This is a strange book indeed, and it tells even more about Lois Crisler than it does about the wolf bitch.

Hal Borland
Author and Naturalist

Waterfowl: Their Biology and Natural History, by Paul A. Johnsgard. *University of Nebraska Press, $8.95; 138 pp., illus.*

Paul A. Johnsgard is well prepared to write a book on the biology of the waterfowl of the world. He has already made impressive contributions to the literature, including a previous book, *Handbook of Waterfowl Behavior*. His new book attempts to survey, in one volume, the 148 species of ducks, geese, and swans that make up the world's waterfowl. The work is lavishly illustrated with 148 photographs, 59 of which are in color. Most of the photography was done by the author at The Wildfowl Trust at Slimbridge, England, in an earnest attempt to include a photograph of each species of living waterfowl. Recognizing that questions of systematics would best be referred to Delacour's *The Waterfowl of the World*, the author has sensibly concentrated his text on a summary of the biology of waterfowl with special emphasis on behavior. While the book is intended for the general reader, biologists will find that much of the behavioral and biological literature on Anatidae is ably and interestingly summarized.

The text begins with a survey of the evolution and systematic relationships of the family Anatidae and continues with chapters giving very readable treatments of distribution, migration, ecology, and behavior. Further chapters take up sound production, breeding biology, molts, plumages, and hybridization. Johnsgard also includes brief discussions of research needs and conservation problems. The last two chapters are in the nature of appendices: one being a key to the identification of unfamiliar wildfowl; the other is an annotated list of the waterfowl of the world. The author's wide field experience enables him to draw on his own observations in discussing these topics of waterfowl biology. The specifics make for stimulating reading in subjects that might otherwise have drifted into vague generalities. Amateur naturalists and waterfowl watchers will be particularly pleased with Johnsgard's presentation of social behavior. The courtship displays, which are so much in evidence among spring mi-

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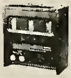

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grants, are categorized and described with comment on their probable significance. Several attractive plates of the author's black-and-white sketches illustrate these displays.

Mode of documentation is always a knotty editorial decision in a book that is intended for wide reader appeal. In this case, it appears that the editors have wisely chosen not to include citations in the text. This occasionally leads to ambiguity, but readers who wish to pursue subjects in depth will find a selected bibliography for each chapter. In checking 20 titles in the bibliography against their original sources, only two small errors turned up.

The format of this book is most pleasing, with attractive and eye-soothing typography. Unfortunately, many of the photographic reproductions do not attain a similar level of quality. Johnsgard's camera work sometimes fails to achieve the level of perfection and clarity that is our expectation in bird photography. Furthermore, both black-and-white and color reproductions contain blemishes, probably dust particles magnified by the enlargement process. Among the color prints this is not so serious, but in some of the black-and-white enlargements the circular blemishes distract from the content of the plate.

In a book of this scope it is inevitable that some gaps occur in subject matter. The author's treatment of waterfowl conservation is largely confined to the preservation of rare and endangered species. In a field where tremendous accomplishments have been made in both management and research over the past 30 years, it is regrettable that such a limited view is presented. Recognition of the importance of maintaining habitat is overlooked and the concepts of flyway and species management—based on international programs measuring production, population structure, and harvest—are ignored.

Despite these shortcomings, the reader will be well rewarded with an investment in this book. It brings together a unique combination of photos and text which will be of great interest to both amateur and professional waterfowl observers.

DANIEL Q. THOMPSON
Cornell University

KIKI: TEN THOUSAND YEARS IN A LIFETIME, by Albert Maori Kiki. *Frederick A. Praeger, $4.95; 190 pp., illus.*

Nominally this is the story of a native Papuan, Maori Kiki, born in 1931 into a village near the great Purari River, as far from the mainstream of twentieth-century affairs as the subtitle of the book suggests. But this autobiography is far more than the

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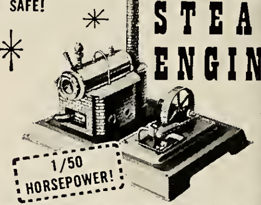

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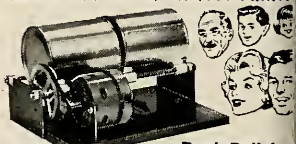

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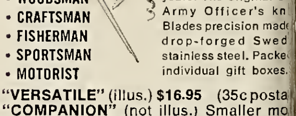

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Galapagos—Andes—Ecuadorian Oriente
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Leader: Miss Alice Johannsen, Diector McGill University Museums, Montreal.

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story of one man's emergence. Rather, it is the unfolding drama of a people thrust willy-nilly into a political chess game where the possible combinations have the making of an end play that may defy the predictions of the most sophisticated expert.

No man outlives or even outgrows his early conditioning. Later experience colors his personality, but family and tribal training and beliefs shape many future actions. Fortunate is a man like Kiki, who came of age in a community disciplined by a hard environment. His progress from one initiation to another gave him the pride of growing up, of belonging to a group. This conditioning made life at once easier and more difficult as Kiki met the alien culture of a more complex world head-on. Here was a system of discipline with punishments and rewards that he did not at first understand and against which he often rebelled. In time, he learned to compromise with men and events and to adjust to the new tide of culture sweeping his land, although he has never made peace with this world.

A library of reading can convey only the vaguest idea of what life is like (the hopes and fears, the sounds and sights) in a Stone Age village in New Guinea, this largest of tropical islands. Primitive is an adjectival misnomer for such a community; there is so much more than meets the eye. Here one finds traditions, ceremonies, codified laws, practical and theistic artisanship of the highest quality: in short, a complex community shaped by the bitter struggle for survival, and existing in uneasy ecological equilibrium. Four hundred years of discovery, exploration, and relatively mild exploitation by colonial powers did little to upset this balance. But World War II dropped New Guinea into the frying pan. And postwar New Guinea knows the fire of change that will permit no return to the mountain-walled societies of old.

As a boy of ten Kiki was a reluctant pupil in a mission school. Life so often turns on minor events; in this case the mission head taught him the rudiments of first aid. This interest eventually led Kiki to the job of "doctor boy," and later into contact with Albert Speer, an Australian medical assistant, who not only gained Kiki's whole-hearted respect but also inspired him to go eventually to Fiji for medical training. Returning home as a trained pathologist, he worked in a hospital, founded the Kerema Welfare Association, visited the island of Buka as part of a medical team, became a welfare assistant, attended the Administrative College, was promoted to welfare officer, and then was appointed a patrol officer. Every facet of this many-sided life brought him into contact with a variety

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Leader: Dr. Edgar Reilly Jr., Curator New York State Museum, Albany, N.Y.

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The Bucegi Mountains, highest peak 8225 ft. are rich in game animals—boar, bear, chamois—and in birds. The 1968 group admired the wall-creepers of the Bucegi. The Fagaras Range, more than 50 peaks over 7000 ft. over a length of 43 miles, is an alpine national park of unsurpassed grandeur.

The Maramures, a densely wooded area of great scenic beauty in the northwest of Rumania are also the country's richest folklore region. The Bucovina has the world-famous painted churches, late Byzantine folkloric churches of original form, painted on the outside from top to bottom with well preserved frescoes.

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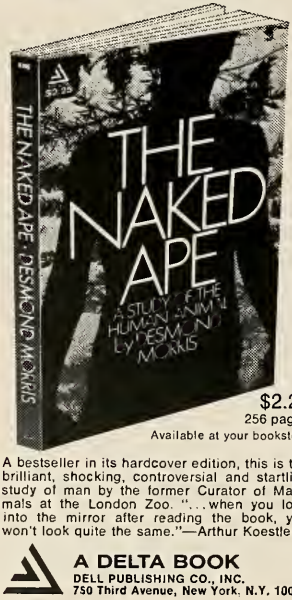

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of people. During these formal
years he was in the thick of the so
and political ferment that has char
terized the postwar years in Papua-N
Guinea. Political parties have th
genesis in times like these. PAN
PATI (Papua-New Guinea Uni
Party) was born. The organization
the first House of Assembly gave
ited scope to party politics, but the
House of Assembly has a member
PANGU PATI as its Speaker,
fourteen members of the party w
elected to the House. Although All
Kiki was defeated in his bid for e
tion, he will doubtless play a lead
part in the councils of PANGU PA
At 37, Kiki is young for a politician

Favored by the timing of swi
moving events, certain strong pers
alities come to the fore. Some are h
ored and inspire followings; oth
gather distrust and are whipped by
backlash effect of too sudden
poorly understood change. Albert
has run the gamut of those experien
that confront every man who follow
vision. Where this vision will lead
one knows, but his future and tha
his country are unfolding ever m
rapidly. One hopes that the futur
this beloved country may be shaped
strong men, both Papuan and Aus
lian, who serve a higher cause than
of personal ambition.

HOBART M. VAN DEU
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WILD SANCTUARIES, by Robert Mur
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illus.

Art, literature, and the common
erences of conservation remind
within our urban enclosures, of
wider ranges and freer creatures,
stimulating our latent urge to rep
ish our souls by returning to
sources. In green pastures, on ga
sweeps of desert or in swamp solit
wild sanctuaries restore the spiri
man and release him from rectangl

Thus, Stewart Udall introduces
remarkable book by Robert Mur
which in turn will serve to intro
many of the American people to
national wildlife refuges of this c
try. Despite their 300 separate a
which include 28,500,000 acres of l
the wildlife refuges are not as
known to Americans as the better
licized and overcrowded national pa
Part of this is a result of past po
since the refuges were thought of
inally as serving wildlife, particul
waterfowl. Only recently has it
clearly recognized that they must
Secretary Udall points out, serve
as refuges for people.

In 1903 the national wildlife re
had its beginning when little Pel
Island in Florida was establishe

federal reservation. Since then the
phasis in the refuge system has been
ward the protection of birds, in par-
ular the migratory waterfowl that
pend on small key areas where they
st rest or feed. However, as Robert
urphy shows, our wild sanctuaries
w serve to protect a much wider
nge of species, from bison, timber
lves, and brown bears down to coati-
ndis and alligators. They are spread
ross the United States, from the
ctic slopes of the Brooks Range to
lebra off Puerto Rico, from Laysan
the Hawaiian chain to Moosehorn in
ine, and include virtually all major
bitats in between.

The price of this book is a reflection
the number and quality of its illus-
tions, in color and black and white,
luding reproductions of many re-
rkable earlier American paintings
d illustrations. The book contains the
st complete and outstanding group
wildlife photographs I have yet seen
one volume. For these alone it would
worth owning.

However, this is not just a big pic-
e book. The text is a fascinating ac-
unt of the story of America's wildlife
m the days of primitive abundance,
ough the dark period of slaughter
d destruction, to the restoration that
s come through conservation action.
e book lists and gives some account
most refuges, but provides long ac-
unts of representative refuges from
h of the major regions of the coun-
. These are enough to make anyone
o cares for wildlife and wild coun-
want to pack up and go. As a result
Robert Murphy's efforts, I suspect
t the number of visitors to the wild-
refuges each year will soar far
ve the 20 million who have gone
re in the past. The Bureau of the
dget had better take note and per-
t the Bureau of Sport Fisheries and
ldlife to build in the necessary safe-
rds. The refuges are, after all, for
dlife first.

RAYMOND F. DASMANN
The Conservation Foundation

E DAY OF THE DINOSAUR, by L.
rague de Camp and Catherine Crook
Camp. *Doubleday & Co., $6.95; 319*
, *illus.*

here are few people who can speak
more charmingly and enlightened-
about scientific subjects than L.
rague de Camp, and when his wife,
therine, contributes her writing tal-
s as well, it becomes virtually im-
sible to find fault.

n *The Day of the Dinosaur*, Mr. and
s. de Camp have produced a gener-
ly illustrated and carefully detailed
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giant reptiles of the Mesozoic. The tale is an exciting one in itself and the de Camps, mercifully, have refused to "glamorize" it by using a febrile style. The book reads, in fact, like a pleasant and informal lecture, given at their ease, by a pair of enormously rational and urbane individuals.

Nor do the de Camps confine themselves to the entirely descriptive. They make the dinosaurs come alive by picturing them in action. Why does a stegosaur have the peculiar, upended bony structures along its spine? The de Camps have them instinctively turning their back on oncoming carnosaurs. "Attacked from the rear by random snapping and lunging, the stegosaur was well protected. The attacking carnosaur would not only be gored by the lashing tail spikes but would also gash its jaws on the plates."

Indeed, the de Camps introduce the book with a most remarkable first chapter in which Sprague de Camp's experience as one of the foremost science fiction writers in America clearly shows itself. This first chapter is an evocation (the best I know) of a typical day in the Mesozoic. The lizardlike reptiles, the birdlike reptiles, the primitive mammals, the clumping sauropods, the small and large carnosaurs, all play their role in an intricate ecological pattern, unmarked (and unmarred? I wonder) by intelligence. From dawn to dusk, we have the description of a world no man ever saw or will see, but one that has arisen out of the discovery of some fossilized bones and through the active but disciplined imagination of a handful of dedicated paleontologists. (The book deals, satisfactorily, with the paleontologists and their discoveries, too, especially with the Cope-Marsh feud.)

The last chapter of the book deals with the effects on contemporary man of the great discoveries of paleontology: the impetus given to the search for giant living creatures—and to romancing about them—and the ferocious object lesson given on the subject of mass extinctions, or "great dyings."

We are in the midst of a great dying now, point out the de Camps, brought on by man himself. However, they do not succumb to the temptation to grow strident and anguished; but with a gentle and eloquent melancholy, they say: "The existence of the wilderness with its wildlife is one of the things that makes the world interesting. If it is right to prefer freedom to imprisonment, variety to monotony, and color to drabness, then it is right to save as much as we can of the wilds and their dwellers."

Oh, that mankind would listen.

ISAAC ASIMOV
Boston University

Briefly Noted:

EXPLORING SPACE WITH A CAMER edited by Edgar M. Cortright. *Gover ment Printing Office, $4.25; 214 pp illus.*

Pictures of launching pads an blast-offs are missing in this phot graphic record of the first decade o space exploration. Instead, th National Aeronautics and Space A ministration offers its choice of the be photographs among the thousands th hand-held and robot cameras hav taken. Not that the earth stay modestly out of the picture. It pose often in photos sent back b weather-mapping satellites; its fac lights up for the camera on an Orbite circling the moon; and it steals th show in the section called "Fro Cameras Held by Men," a portfolio o photos that show our planet i strangely beautiful colors and exot land-sea-cloud patterns that must b seen to be believed. B.C

THE IMMINENT RAINS, by John Hemi way. *Little, Brown and Co., $6.95; 1 pp., illus.*

Traveling across Africa in his Lar Rover, John Heminway visited the r maining African pioneers—white hun ers, government men, and missionari —who speak of the Africa of the pa with nostalgia and view the future wi foreboding. Mr. Heminway evokes t sights, smells, and sounds of Afri while he offers sympathetic portrai of those men to whom progress mea disaster. The author wryly observ that "neither men, nor government nor virgin land . . . can escape t future." Mr. Heminway's sister, Hilar contributed the charming line dra ings of African wildlife. C.

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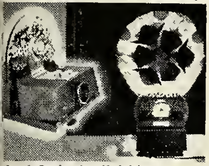

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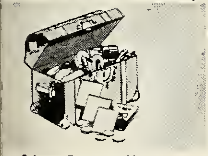

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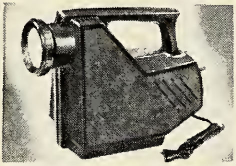

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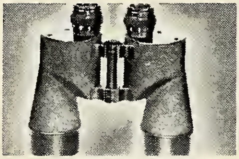

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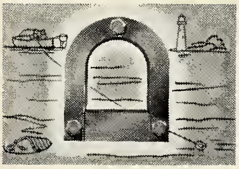

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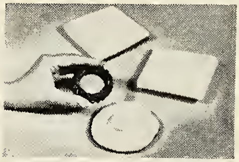

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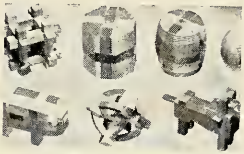

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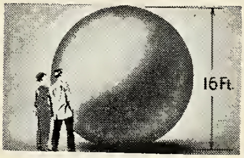

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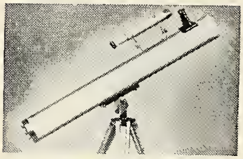

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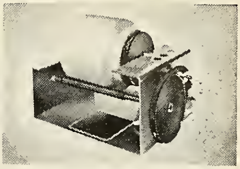

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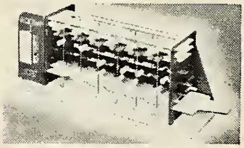

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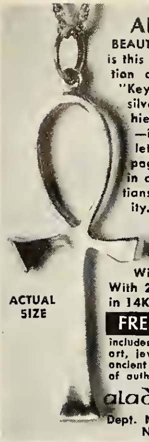

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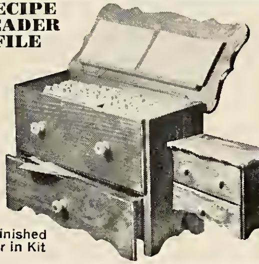

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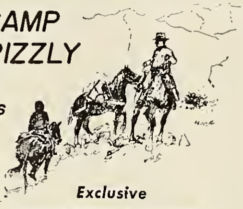

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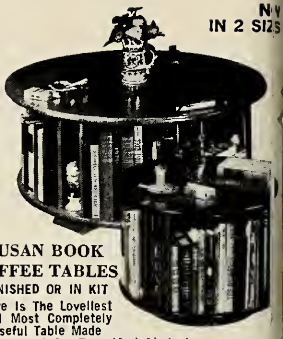

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1. The contest is strictly for amateur photographers. Everyone is eligible except employees of Natural History or of The American Museum of Natural History, members of their families, and individuals who personally, or any members of whose families, are engaged in the manufacture, sale, commercial finishing, or professional use of photographic goods.

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3. Color photographs:
   a. Color pictures may be submitted as either a transparency or a print.
   b. Transparencies must be originals and must be mounted in cardboard only.
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5. On the back of each print or on the transparency mount must appear: name and address of the photographer, description of subject, where and when taken, and make and model of camera.

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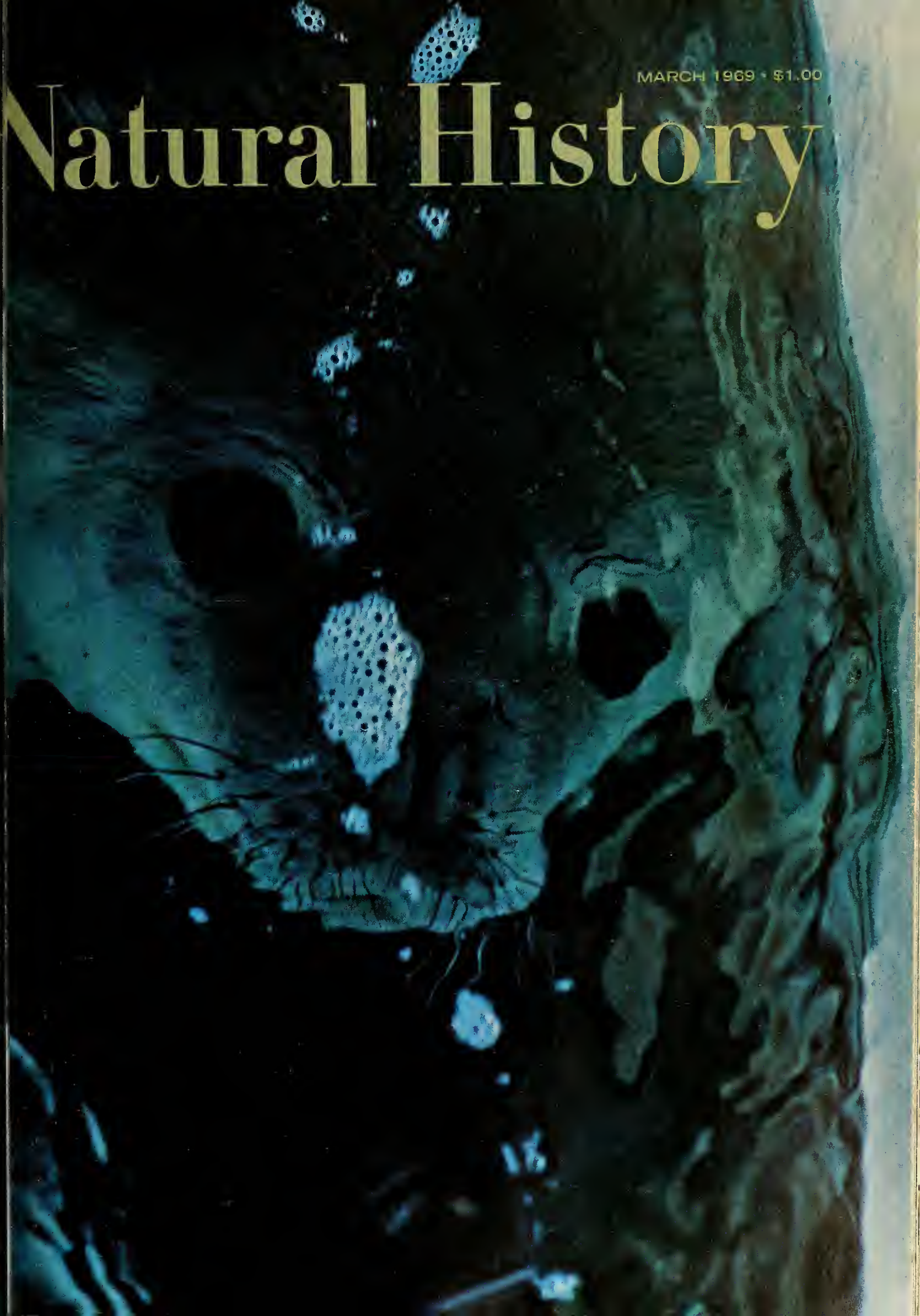

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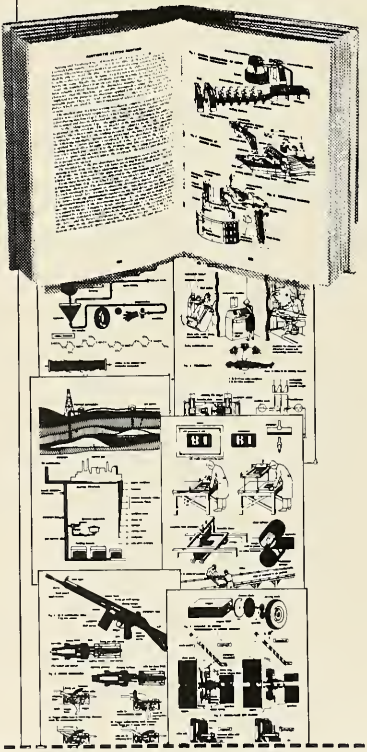

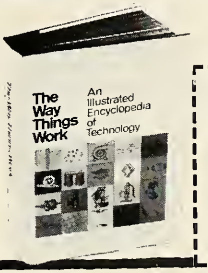
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THE AUTHORS

The research leading to the publication of "The Myth of the Peaceful Atom" was begun in 1963 by **Elizabeth Hogan**. Coauthor **Richard Curtis** joined in the effort in 1967 and the two have since conducted a thorough study of the ramifications of the commercial use of atomic energy. Their investigation led to consultations with nuclear scientists, engineers, and biologists, and has culminated in a book on peaceful uses of the atom, which will be published by Doubleday during the summer of 1969. Both Hogan and Curtis are free-lance writers who work and live in New York City.

A National Science Foundation grant to the New York Zoological Society enabled **Carleton Ray** to lead three expeditions to Antarctica to study the Weddell seal: in 1963, with David Lavallee and the Arctic Health Research Center's Elmer T. Feltz; in 1964, with the addition to that team of bioacousticians W. E. Schevill and W. A. Watkins and diver-photographer Peter Gimbel; and again in 1966. Dr. Ray, who is Associate Professor of Pathobiology at Johns Hopkins University, is currently studying polar marine mammals. He is a member of the Subcommittee of Specialists on Seals of the Scientific Committee on Antarctic Research, and the author of three books and numerous scientific papers and articles, including four previous articles for NATURAL HISTORY.

A deep-sea scuba diver since 1956 and a photographer since his youth, **Michael A. deCamp** has pursued these complementary activities from Greece to Alaska, and has documented many deepwater shipwrecks on the New York and New Jersey coasts. His participation in the United States Antarctic Research Program as diver-photographer on a 1966 study team, resulted in his coauthorship of the seal article. On dry land, Mr. deCamp is a popular lecturer and teaches science at the Peck School, Morristown, N.J.

Bert Dugdale's interest in spiders began as a child. Later, while working as a structural engineer, he beg
to see similarities between the pr
lems faced by a spider building
web and those that confront c
struction engineers. This led to
desire to observe and record the
tual weaving of a web, an oppor
nity that came one morning in 19
and the subject of his article t
month. Mr. Dugdale is now retir
His article was brought to the att
tion of NATURAL HISTORY by
Peter Witt, Director of Research
the North Carolina Department
Mental Health, who has studied
tensively the effects of drugs on
web-weaving behavior of spiders.

The material for **David Cav**
naro's article on Galapagos inse
is drawn from his 1964 research
those islands, conducted as a meml
of the Galápagos International Sci
tific Project. Mr. Cavagnaro th
left the expedition and stayed on
the Galápagos, working "as a ran
hand of sorts on a farm." He is pr
ently with the Oakland Museum
California. His first field work w
done in 1961-62, when he cover
35,000 miles on an entomological
pedition through India, Pakista
Malaya, Thailand, and Australia.

Dr. Alex L. Shigo, principal n
cologist at the Northeastern For
Station of the United States For
Service, wrote the article on tree
cay. Currently, Dr. Shigo is directi
a research project on discolorati
and decay processes in living tre
with the hope of developing relial
control methods. The author of mc
than forty-five scholarly articles
plant pathology, Dr. Shigo also pla
the clarinet and saxophone, both ja
and classical.

Frank L. and **Dora Lambrech**
authors of "Victorian Fashions
the Edge of the Kalahari," encou
tered the Herero tribe when th
were doing field work in Botswar
Mr. Lambrecht has published mo
than 40 articles based on his studi
of insect-vectors of disease, main
mosquitos and tsetse flies. The La
brechts are presently living in t
Seychelles Islands, where Mr. La
brecht is doing research for t
World Health Organization. M
Lambrecht has published several a
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The Myth of the Peaceful Atom

by Richard Curtis and Elizabeth Hogan

"What is past is past, and the damage we may already have done to future generations cannot be rescinded, but we cannot shirk the compelling responsibility to determine if the course we are following is one we should be following."

So said Senator Thruston B. Morton of Kentucky on February 29, 1968, upon introducing into Congress a resolution calling for comprehensive review of federal participation in the atomic energy power program. Admitting he had been remiss in informing himself on this "grave danger," Morton said he had now looked more deeply into nuclear power safety and was "dismayed at some of the things I have found—warnings and facts from highly qualified people who firmly believe that we have moved too fast and without proper safeguards into an atomic power age."

Senator Morton's resolution on nuclear power was by no means the only one before Congress in 1968. Indeed, more than two dozen legislators urged investigation and reevaluation of this program. This fact may come as a surprise to much of the public, for the belief is widespread that the nuclear reactors being built to generate electricity for our cities are safe, reliable, and pollution-free. But a rapidly growing number of physicists, biologists, engineers, public health officials, and even staff members of the Atomic Energy Commission itself—the government bureau responsible for regulation of this force—have been expressing serious misgivings about the planned proliferation of nuclear power plants. In fact, some have indicated that nuclear power, which Supreme Court Justices William O. Douglas and Hugo L. Black described as "the most deadly, the most dangerous process that man has ever conceived," represents the gravest pollution threat yet to our environment.

As of June, 1968, 15 commercial nuclear power plants were operating or operable within the United States, producing about one per cent of our current electrical output. The government, however, has been promoting a plan by which 25 per cent
of our electric power will be ger
ated by the atom by 1980, and h
by the year 2000. To meet this go
87 more plants are under constr
tion or on the drawing boards.
though atomic power and reac
technology are still imperfect
ences, saturated with hazards
unknowns, these reactors are go
up in close proximity to heavy p
ulation concentrations. Most of th
will be of a size never previously
tempted by scientists and engine
They are, in effect, gigantic nucl
experiments.

As most readers will recall, ato
reactors are designed to use the
mendous heat generated by splitt

ns. They are fueled with a con-
rated form of uranium stored in
-walled tubes bound together to
n subassemblies. These are placed
he reactor's core, separated by
rol rods that absorb neutrons
thus help regulate chain reac-
s of splitting atoms. When the
are withdrawn, the chain reac-
s intensify, producing enormous
ntities of heat. Coolant circulated
ugh the fuel elements in the reac-
ore carries the heat away to heat-
ange systems, where water is
ight to a boil. The resultant
m is employed to turn electricity-
erating turbines.

tated in this condensed fashion, the process sounds innocuous enough. Unfortunately, however, heat is not the only form of energy produced by atomic fission. Another is radioactivity. During the course of operation, the fuel assemblies and other components in the reactor's core become intensely radioactive. Some of the fission by-products have been described as a million to a billion times more toxic than any known industrial chemical. Some 200 radioactive isotopes are produced as by-products of reactor operation, and the amount of just one of them, strontium-90, accumulated in a reactor of even modest (100–200 megawatt) size, after it has been operative for six months, is equal to what would be produced by the explosion of a bomb 190 times more powerful than the one dropped on Hiroshima.

Huge concentrations of radioactive material are also to be found in nuclear fuel-reprocessing plants. Because the intense radioactivity in a reactor core eventually interferes with the fuel's efficiency, the spent fuel assemblies must be removed from time to time and replaced by new, uncontaminated ones. The old ones are transported to reprocessing plants where the contaminants are separated from the salvageable fuel as well as from plutonium, a valuable by-product. Since no satisfactory means have been found for neutralizing or for safely releasing into the environment the radioactive liquid containing the contaminants, it must be stored until it is no longer dangerous. Thus, reprocessing plants and storage areas are immense repositories of "hot" and "dirty" material. Furthermore, routes between nuclear power plants and the reprocessing facility carry traffic bearing high quantities of such material.

Even from this glimpse it will be apparent that public and environmental safety depend on the flawless containment of radioactivity every step of the way. For, owing to the incredible potency of fission products, even the slightest leakage is harmful and a massive release would be catastrophic. The fundamental question, then, is how heavily can we rely on human wisdom, care, and engineering to hold this peril under absolute control?

Abundant evidence points to the conclusion that we cannot rely on it at all.

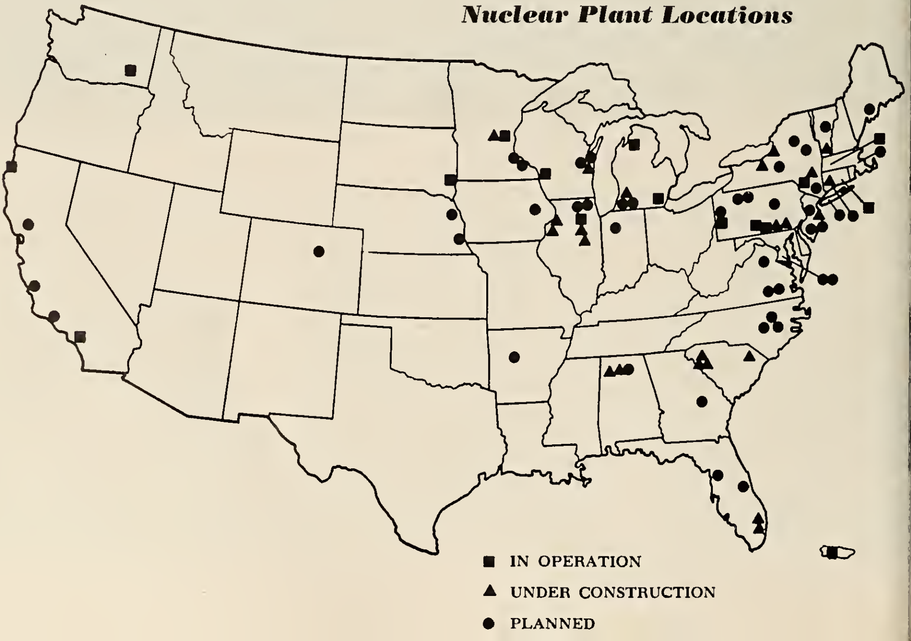
The hazards of peaceful atomic power fall into two broad categories: the threat of violent, massive releases of radioactivity or that of slow, but deadly, seepage of harmful products into the environment.

Nuclear physicists assure us that reactors cannot explode like atomic bombs because the complex apparatus for detonating an atomic warhead is absent. This fact, however, is of little consolation when it is realized that only a *conventional* explosion, which ruptures the reactor mechanism and its containment structure, could produce havoc on a scale eclipsing any industrial accident on record or any single act of war, including the atomic destruction of Hiroshima or Nagasaki.

There are numerous ways in which such an explosion can take place in a reactor. For example, liquid sodium, which is used in some reactors as a coolant, is a devilishly tricky element that under certain circumstances burns violently on contact with air. Accidental exposure of sodium could initiate a chain of reactions: rupturing fuel assemblies, damaging components and shielding, and destroying primary and secondary emergency safeguards. If coolant is lost, as it could be in some types of reactors, fuel could melt and recongeal, forming "puddles" that could explode upon reaching a critical size. If these explosions are forceful enough, and safeguards fail, some of the fis
products could be released ou
the plant and into the environ
in the form of a gas or a clou
fine radioactive particles. Under
uncommon atmospheric condit
such as an "inversion," in whi
layer of warm air keeps a co
layer from rising, a blanket of ra
activity could spread insidio
over the countryside. Another p
bility is that fission products c
be carried out of the reactor
into a city's watershed, for all
tors are being built on lakes, ri
or other bodies of water for coo
purposes.

What would be the toll of su
calamity?

In 1957 the Atomic Energy C
mission issued a study (design
Wash. —740), largely prepared
the Brookhaven National Lab
tory, that attempted to assess
probabilities of such "incidents"
the potential consequences. Som
its findings were stupefying: F
the explosion of a 100–200 m
watt reactor, as many as 3,400 pe
could be killed, 43,000 injured,
as much as 7 billion dollars of p
erty damage done. People coul
killed at distances up to 15 miles
injured up to 45. Land contam



Nuclear Plant Locations

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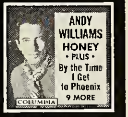
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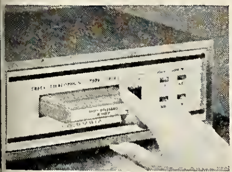

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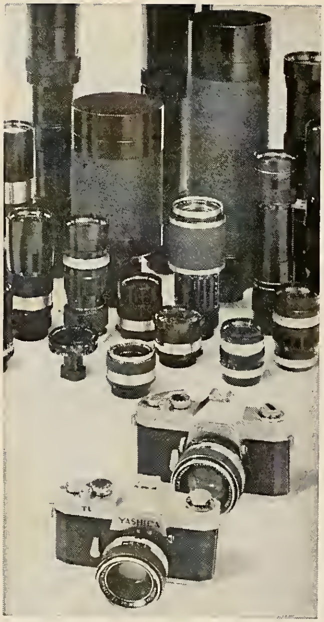

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tion could extend for far greater distances: agricultural quarantines might prevail over an area of 150,000 square miles, more than the combined areas of Pennsylvania, New York, and New Jersey.

The awful significance of these figures is difficult to comprehend. By way of comparison, we might look at one of the worst industrial accidents of modern times: the Texas City disaster of 1947 when a ship loaded with ammonium nitrate fertilizer exploded, virtually leveling the city, killing 561 people, and causing an estimated $67 million worth of damage. Appalling as this catastrophe was, however, it does not begin to approach the potential havoc that would be wreaked by a nuclear explosion occurring in one of the plants now being constructed close to several American cities.

The scientists and engineers who produced the Brookhaven Report optimistically ventured to give high odds against such an occurrence, asserting that the structures, systems, and safeguards of atomic plants were so engineered as to render it practically incredible. At the same time, though, the report was replete with such statements as:

> "The cumulative effect of radiation on physical and chemical properties of materials, after long periods of time, is largely unknown."

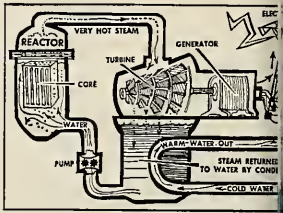
> "Much remains to be learned about the characteristics and behavior of nuclear systems."

> "It is important to recognize that the magnitudes of many of the crucial factors in this study are not quantitatively established, either by theoretical and experimental data or adequate experience."

Even if the report had been founded on more substantial understanding of natural and technical processes, many of the grounds on which the Brookhaven team based its conclusions are shaky at best.

For one thing, all of us are familiar with technological disasters that have occurred against fantastically high odds: the sinking of the "unsinkable" *Titanic*, or the November 9, 1965, "blackout" of the northeastern United States, for example. The latter happening illustrates how an "incredible" event can occur in the electric utility field, most experts agreeing that the ch of circumstances that brought about was so improbable that odds against it defy calculation.

Congressional testimony giver 1967 by Dr. David Okrent, a for chairman of the AEC's Advis Committee on Reactor Safegua demonstrated that fate is not alw a respecter of enormously adv odds. "We do have on record c where, for example, an applic appearing before an atomic sa and licensing board, stated tha mathematical impossibility had curred; namely, one tornado t out five separate power lines t reactor. If one calculated strictly the basis of probability and m plied the probability for one line times, you get a very small num indeed," said Dr. Okrent, "bu happened."



Boiling Water Reactor

A disturbing number of rea accidents have occurred—with sh luck playing an important part averting catastrophe—that seem have been the product of incredi coincidences. On October 10, 19 for instance, the Number One (reactor) at the Windscale Wo in England malfunctioned, spew fission products over so much te tory that authorities had to seize milk and growing foodstuffs i 400-square-mile area around plant. A British report on the i dent stated that *all* of the react containment features had fai And, closer to home, a meltdown fuel in the Fermi reactor in Lago Beach, Michigan, in October, 19 came within an ace of turning i a nuclear "runaway." An explos release of radioactive materials averted, but the failures of Fer safeguards made the event, in words of Sheldon Novick in *Scien and Citizen*, "a bit worse than 'maximum credible accident.' "

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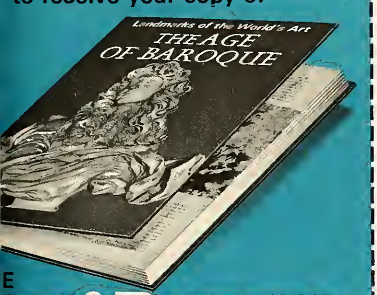
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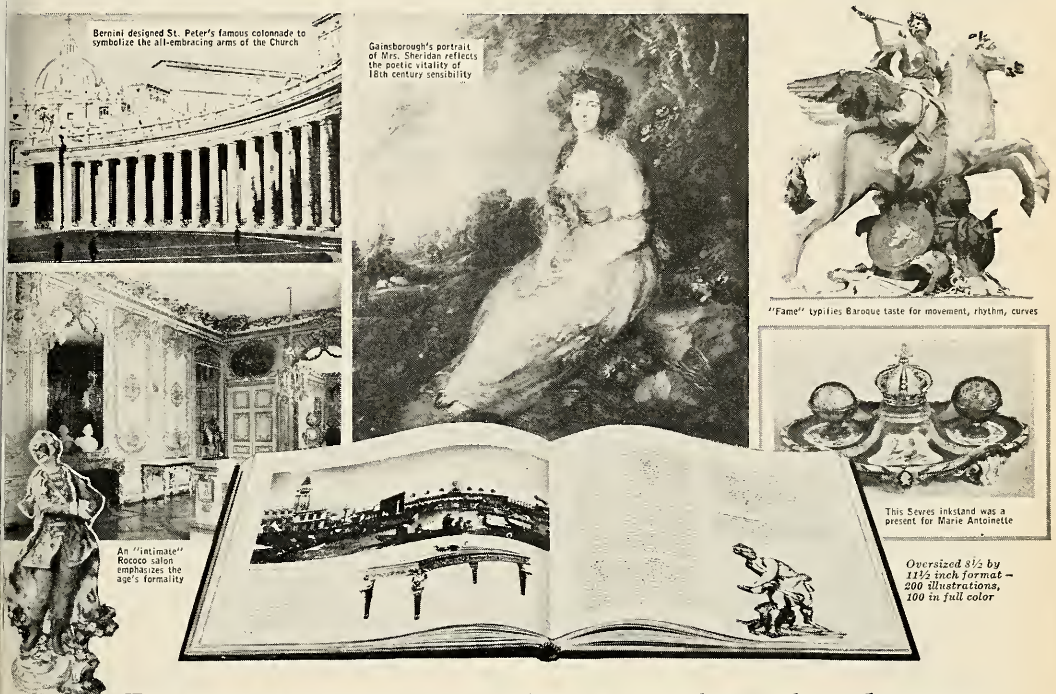

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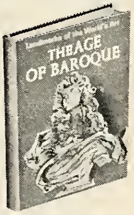

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The atomic industry has attempted to design components and safeguards so that failure of one vital system in a plant will not affect another, resulting in a "house of cards" collapse. However, two highly regarded authorities, Theos J. Thompson and J. G. Beckerley, in a book on reactor safety advise us not to place too much faith in claims of independent safeguards: "A structure as complex as a reactor and involving as many phenomena is likely to have relatively few completely independent components." Many manufacturers and utility operators have resisted the idea of producing "redundant safeguards" on the grounds of excessive cost.

Investigations of reactor breakdowns usually disclose a number of small, seemingly unrelated failures, which snowballed into one big one. A design flaw or a human error, a component failure here, an instrumentation failure there—all may coincide to contribute to the total event. Thompson and Beckerley, examining several atomic plant accidents, pinpointed 13 different contributing causes in three of the accidents that had occurred up to the time of their 1964 study.

Among the many factors contributing to reactor accidents, the human element is the most difficult to quantify. And perhaps for that reason, it has been largely overlooked in the AEC's assessments of reactor safety. Yet, a private researcher of nuclear accidents, Dr. Donald Oken, M.D., Associate Director of the Psychosomatic and Psychiatric Institute of Michael Reese Hospital in Chicago reported: "A review of reports of past criticality and reactor incidents and discussions held with some of the health personnel in charge reveal a number of striking peculiarities in the behavior of many of those involved—in which they almost literally asked for trouble."

AEC annuals are full of reports of human negligence: 3,814 pounds of uranium hexafluoride lost owing to an error in opening a cylinder; a $220,000 fire in a reactor because of accidental tripping of valves by electricians during previous maintenance work; numerous vehicular accidents involving transport of nuclear materials. None of these accidents led to disaster, but who will warrant that, with the projected proliferation of power plants and sat
lite industries in the coming decac
a moment's misjudgment will n
trigger a nightmare? Perhaps wors
the likelihood of sabotage has scarc
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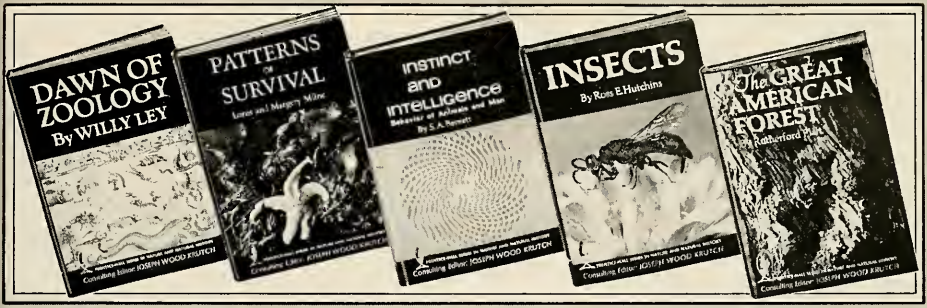
conventional industrial procedu
will wreck the more exacting on
And when the technology is not on
exacting but hazardous in the e
treme, then a trivial oversight,
minor defect, a moment's inattentic
may spell doom.

While there is little doubt th
American technology is the most r
fined on earth, there is ample reas
to believe that it has more than m
its match in the seemingly insu
mountable problems posed by th
peaceful atom. Societies of profe
sional engineers, and others co
cerned with establishing technic
and safety criteria for the nucle
industry, have described betwee
2,800 and 5,000 technical standar
that are necessary for a typical rea
tor power plant in such areas
materials, testing, design, electric
gear, instrumentation, plant equi
ment, and processes. Yet, due to th
rapidity with which the nuclear i
dustry has developed, as of March
1967, only about 100 of these ha
been passed on and approved fo
use.

It is not surprising, then, to lear
that serious technical difficulties a
turning up in reactor after reacto
At the Big Rock Point Nuclear Plan
a relatively small reactor ne
Charlevoix, Michigan, control ro
were found sticking in positio
studs failing or cracked, screws jo
tled out of place and into key m
chanisms, a valve malfunctioning f



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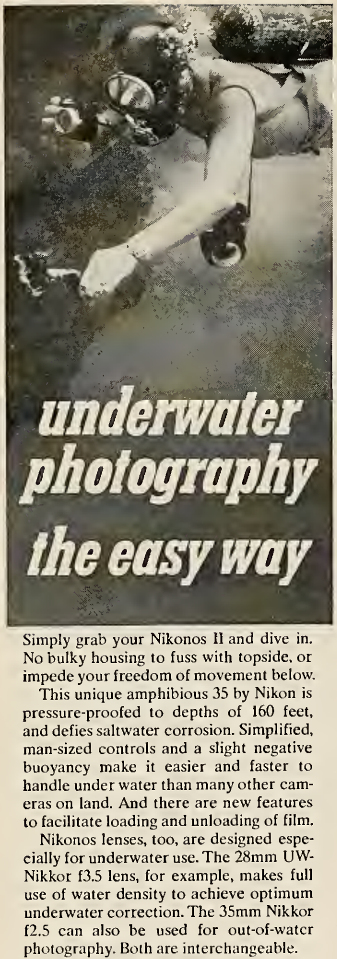

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more than a dozen reasons, foreign material lodging in critical moving parts, and welds cracked on every one of sixteen screws holding two components in place. A reactor at Humboldt Bay in California manifested cracks in the tubes containing fuel: in order to keep costs down, stainless steel had been used instead of a more reliable alloy. The Oyster Creek plant in New Jersey showed cracks in 123 of 137 fuel tubes, and welding defects at every point where tubes and control-rod housings were joined around the reactor's vessel. Reactors in Wisconsin, Minnesota, Connecticut, Puerto Rico, New York, and elsewhere have experienced innumerable operating difficulties, and some, such as the $55 million Hallam plant in Nebraska have been forced to shut down for good, owing to plant malfunction.

Chilling parallels can be drawn between failures in nuclear utility technology and in the nuclear submarine program. In October, 1962, Vice Admiral Hyman G. Rickover, Director of AEC's Division of Naval Reactors, took the atomic industry to task in a speech in New York City:

"It is not well enough understood that conventional components of advanced systems must necessarily meet higher standards. Yet it should be obvious that failures that would be trivial if they occurred in a conventional application will have serious consequences in a nuclear plant because here radioactivity is involved. . . ."

Rickover went on to cite defective welds, forging materials substituted without authorization, violations of official specifications, poor inspection techniques, small and seemingly "unimportant" parts left out of components, faulty brazing of wires, and more. "I assure you," he declared, "I am not exaggerating the situation; in fact, I have understated it. For every case I have given, I could cite a dozen more."

The following April, the U.S. atomic submarine *Thresher*, while undergoing a deep test dive some 200 miles off the Cape Cod coast, went down with 112 naval personnel and 17 civilians and never came up again. Subsequent investigation revealed that the sub suffered from many of the same ailments described in Rickover's speech. "It is extremely unfortunate," said Senator John O. Pastore, chairman of the joint co gressional committee that held hea ings on the disaster, "that this trag dy had to occur to bring a number unsatisfactory conditions into th open." We must now ask if the sam will one day be said about a powe plant near one of our large cities.

If a major reactor catastrophe di occur there is good reason to believ that the consequences would be fa worse than even the dismaying to suggested by the 1957 Brookhave Report, for a number of developmen since then have made the threat co siderably more formidable.

The Brookhaven Report's accide statistics, for instance, pertained t a reactor of between 100 and 20 megawatts. But while the 15 rea tors currently operating in th United States average about 18 megawatts, the 87 plants going up c planned for the next decade ar many times that size. Thirty-on under construction average abou 726 megawatts; 42 in the plannin stage average 832; 14 more, planne but without reactors ordered, will av erage 904. Some, such as those slate for Illinois, California, Alabam and New York anticipate capaciti of more than 1,000 megawatts. Co Edison has just announced it intend to build four units of 1,000 meg watts each on Long Island Soun near New Rochelle in teeming Wes chester County—four nuclear rea tors, each with a capacity five to te times that of the reactor described i the Brookhaven Report.

These facilities will accordingl contain more uranium fuel, and be cause it is costly to replace spent fu assemblies (this delicate and dange ous process can take six weeks o longer), the new reactors are designe to operate without fuel replaceme far beyond the six months posited i the Brookhaven Report. As a resul the buildup of toxic fission product in tomorrow's reactors will be fa greater than at present, and an ac cident occurring close to the end o the "fuel cycle" in such a plant coul release fantastic amounts of radi active material.

Most serious of all, perhaps, is tha tomorrow's reactors are now slate for location in close proximity t population concentrations. While th Brookhaven Report had its hyp thetical reactor situated about 3

Continued on page 7

Come talk to the animals.

e rhinoceros, banter a baboon or try to get through to a kongoni. Be- e our two safaris have a lot of the t in them.

the big game reserves are on the rary. Masai-Mara, the Serengeti s, the Ngorongoro Crater (100 square of elephants, giraffe, zebra, ante- gazelle and a pride of lions here and). There's also Lake Manyara Nation- rk and the Samburu Game reserve.

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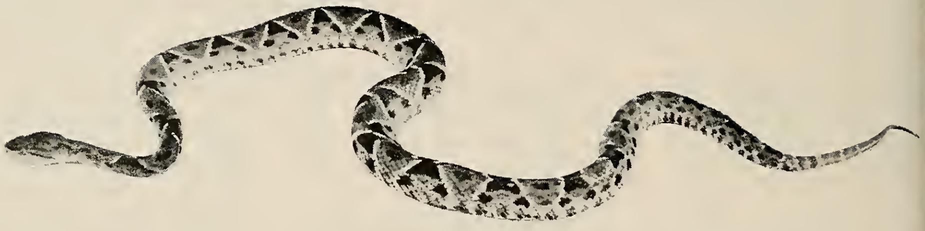

A Naturalist at Large

Archie Car

Not long ago I was bitten by a fer-de-lance. When I failed to succumb, my friends, knowing my vices, assured me that if I ever stopped talking about the experience, I would surely start writing about it, but I said they were wrong. The fright was too personal to write about, I said; and besides, after talking so incessantly about the misadventure, setting it down in print would seem superfluous. But as days passed and raw emotion faded, certain aspects of the happening stuck in my mind because they seemed to shed light upon the natural history of man and *Bothrops.* On this pretext I decided that if I failed to drop dead on the nineteenth day, as Shefton Martinez, the major-domo at the Green Turtle Station, said was likely, I would write my impressions of the curious little nightmare.

I was out looking for reptiles when the *terciopelo* bit me. The *terciopelo* is *Bothrops atrox. Terciopelo,* the local Costa Rican name for the species, is Spanish for velvet and is applied to the snake because of the soft, naplike look of the dorsal dark patches in the color pattern. In Honduras the same snake is known as *barba amarrilla*—yellow chin. The more widespread vernacular name fer-de-lance spread out of the French West Indian island of Martinique, where a similar species lives. *Bothrops* is a genus of the pit vipers, related to the rattlesnakes, copperhead, and cottonmouth moccasin of the United States. The single species *B. atrox* bites more people each year than all the poisonous snakes of the United States put together. This is because its usual habitat is cutover country, in which scattered small farms alternate with second growth in various stages of succession. *Terciopelos* avoid the depths of homogeneous forest except along streams and sloughs, and clearly lean to country in which the crops and clearings of man have extended the habitat of the rodents and ground birds on which the snakes feed. There is a lot of such country in Central America, and the *terciopelo* bites an alarming number of the people who work in it.

It was in that kind of place that the *terciopelo* and I came together—the Caribbean coast of Costa Rica—on the narrow strip of land between the Tortuguero River and the sea. I was out looking for snakes at the time. Five days before, we had cut a trail from the little airstrip on the beach back through dense *caña de cristo* brake to the river, which runs parallel with the shore some three hundred yards away. When the snake bit me I was reconnoitering that trail as a possible reptile-hunting route. The tropical biology class of the Organization for Tropical Studies was coming down in a few days, and I w
trying to map out some field trips
them. That circumstance increa
the bitterness of the mishap. Bei
bitten when you are out looking
snakes only adds humiliation to
other misery.

Being so newly cut, the trail w
not very promising, herpetologica
It takes longer than four days fo
new strip of lighted ground to mell
and draw in the little trailside asso
ations of insects, mice, reptiles, a
birds that gravitate to clearings
the wet tropics. But the *guamil,* de
second-growth stands of canel
grasses and herbaceous vegetati
around the station is so impenetra
that there just being a trail to walk
at all tempts one to walk. So I was
there that afternoon moving slo
along the narrow *pisada,* trying ha
not to overlook any lizard basking
a stem or any slinking chain of sn
in the confusion of dark and light
my feet. Two butterflies dodged p
me down the open aisle, and a cr
hawk whistled from a dead tree
side the trail. But there were no r
tiles to see, not even a half-gro
basilisk or baby green iguana or e
one of the silk-sided *Ameivas,*
teiid lizards that ran so abundar
about the station grounds 200 ya
away. I reached the riverbank pre
disgusted, and stood there a wh
looking out across the river fo

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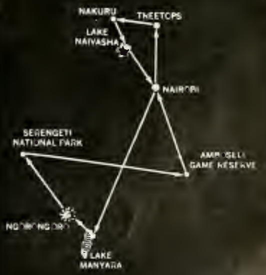

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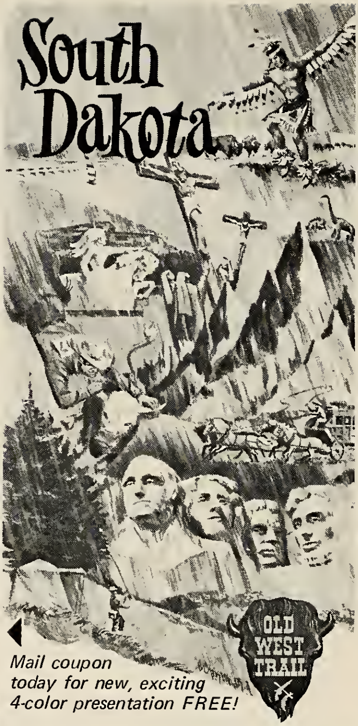

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tarpon rolling or for somebody pa dling by in a log canoe. But there w nothing on the river either, and not ing across in Obed's clearing, whe tapirs sometimes stand beneath almendro tree. Toucans were crea ing in the woods over there, b there was nothing alive to see at a I turned and started walking back the beach, and I had gone about ha way back along the trail when tl snake bit me.

The blow hit low on the back my right calf, just as my foot was li ing for a step. It was hard enough hurt, and to knock the foot forwa a little. My first thought was th there couldn't be anything that cou hit like that in a place with no woo stems to get bent down, sprin back, and slap you hard, as th sometimes do. I tried hard to belie that a snapping-back stem had do it, but the idea wouldn't stick. Wh came clawing its way into my mi instead was that it had to have be a snake. In that place—down amon newly cut, soft green stems of thre year-old seaside *guamil*—the e pected, prevalent, and really qui common snake was the *terciopel* and I knew this well. Nevertheless, grabbed at the one straw of hope could find in my mind and sai "Boa. It could have been a big, ol bad-tempered boa." But that thoug wouldn't stick either, and three pac down the trail from where I had be struck I stopped and slowly turne and walked back two of the longe steps I ever took, and looked dov into the confusion of witheri leaves and shadows and spots light; and clearly. inescapably, I sa the *terciopelo* there. It was a femal She was just about six feet long an big in the middle with a recent mea She was uncoiling and sliding slow away through the thickly set gre stems. I grabbed wildly about f something to hit her with, but ever thing was soft, and either flexible brittle. I quickly saw that to find stick I would have to run clear ba to the river or out to the beach, an in the same rush of thought it can to me how you never run when snake bites you, but sit quietly, better, lie down till help comes. So only watched numbly as the b snake slid out of sight. Then I raise my foot, pulled the pants-leg u above the hurt place—four inch above the top of my tennis shoe—ar a big drop of blood coming out ne perforation, and over a little , a short slash connected with a of tiny blood drops. It was no sic viper wound, and I grasped at : thought too, but guiltily, know- I was only looking for comfort; the next thing I knew, I was run- g. After decades of living around kes, of thinking forward to the e I might be bitten, and of urging ers to be calm and never run in e of snakebite, I found myself run- g in panic down the trail toward beach and home.

t took ten paces or more for me come to my senses and stop run- g, and then force myself to walk wly out to the beach and down ard the station, yelling and whis- g as I walked, and stopping a ple of times to look dismally at punctures on the back of my leg l squeeze out all blood that would ne. I stopped once to knot my dkerchief about my leg and twist s a tourniquet. I couldn't even re- l for sure whether tourniquets e still in vogue as first-aid treat- nt of snakebite, but I put one on way; and then thought of slicing wounds open, but believed I re- mbered some reaction against this ctice too, as a field measure, at st. Anyway, my hunting knife was nt-pointed and dull and would ve had to be hammered in, to bring hoped-for release of supposedly soned blood. So I only walked on, ermittently whistling as loud as I ld and yelling.

I was sure my wife would hear me, d she did; but being a slow runner called Marlin Simon and Mark aulding, who were tagging some tles that lay on the beach up north the station. I could see them start ning in the hot, deep sand and on wind heard Marlin yelling to ask at the trouble was. I yelled back, *erciopelo*," but in the wind the rd got no farther than where Mar- ie was standing in the station rd. But she heard it plainly, and I ld see her go inside to get things dy to do whatever could be done a snake-bitten husband on that esome coast. As I reached the sta- n yard Shefton came running out d said, "What was it Doctor?" and ain I said, "*Terciopelo*." He ked as if I had hit him, because once had vomited blood for eight- hours after a *terciopelo* bite, and

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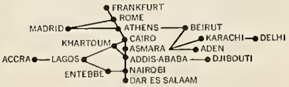

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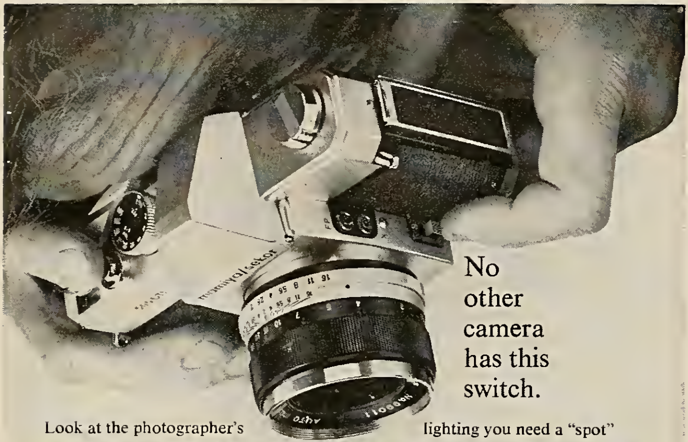
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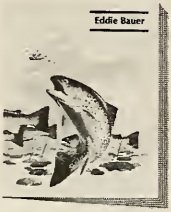
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says he has never since been the ma he was. Marlin and Mark came ru ning up and heard what my proble was. Marlin said, "OK, hold on to u and take it easy." They hobbled m over to the house and up the stair and Margie guided them to my be

It was 3:30 in the afternoon b then. There was no way out to th hospital except by airplane, and th obvious move was to try to call on in. But there was no radio in th place. Marlin, who is an outboar racing man, and Alvin Brian, ou neighbor from the village, wh knows boats and river travel as we as anybody on the coast, put two bi outboard motors on a little alum num boat not rated for even on motor that size, and went streakin down the lagoon to Parismina twenty-four miles away. There was radio at Parismina. There was an other at Barra del Colorado, sixtee miles up the beach the other way. T be safe, our carpenter took Shefton' horse and made off for The Bar.

After looking at the marks of th bite and asking me if it hurt an hearing that it didn't, Margie got ou the antivenin and the snakebite ki and began to read instructions. Un der the pressure of the momen neither of us could remember any thing about the subject with any con fidence, and the antivenin directions were printed too small to read with out a magnifying glass, and finding one had taken quite a while. By th time Margie had dug out a roug grasp of the procedures, anothe half an hour had gone by, and sinc almost anything you do really ough to be done during the first half hour we were getting pretty discouraged

But then I suddenly realized tha except for the first feel of the snake's strike, like a blunt-edge blow across the calf with numbness afterward, I had felt no pain at all. A slight initial swelling just above the bite had spread no farther up after the first five minutes, and now almost an hour had passed since I was bitten. A little wave of optimism went over me—no genuine relief, but enough of an uncertainty to let in the edge of an unlikely hope and to make me want to hold off incising myself. As for injecting antivenin, we were not about to do that until we could work out from Wyeth's microscopic prose exactly how you test a person for allergic reaction to horse serum.

efore previous injections I had n found tolerant of horse serum; they say you can change on short ce, and besides, I had recently n scared by the stuff when it killed oy I knew. He had been bitten le chopping brush on his little n up the beach a way, and had ne to us for help. He came in drag- a *terciopelo*, and showed us re it had struck him, halfway up front of the shin. Like my own of punctures his had not been rammatically diagnostic, being nis case slashes instead of holes. l since he had no symptoms an r after the snake had bitten him, just gave him some coffee and gested that he lie down a while re we did anything else. But he sted that he needed the antivenin. ld him that for some people horse m could be worse than snakebite, he had the local faith in *inyecci- s* and argued with growing anx- . I looked at his leg again and no swelling, and him with no n, no nausea, and no trouble athing. I still couldn't bring my- to give him the injection, and him so.

Bueno, pues," he said in Spanish, ill you give *me* the serum," and I l that was exactly what I advised inst. "No," he said, "I mean, will give me the antivenin to take to *nyeccionista*?" The nearest injec- ist would be up at The Bar, al- st to Nicaragua. I knew that trav- g that far by dugout, up the -choked reaches of *Caño Palmas* oon, was the last thing the boy uld do; but after we had argued hile longer I told him that if he ld lie down and rest until after- n and if then he still insisted on ing the serum to The Bar and uld promise to find an *inyeccion-* who knew how to give the im- ne-reaction test, he could have the ff. But I said I still advised him to take it unless some kind of ptoms appeared.

bout three o'clock he got up, still h no pain or swelling, and said, a man who had kept his side of a gain, "*Bueno?*" So I gave him ee packs of antivenin, and his nd took him away. If I had own he would ride the canoe only to the pass and then go on the rteen miles to Simon Lagoon on t, I would have stopped him, but t is the way he made the trip.

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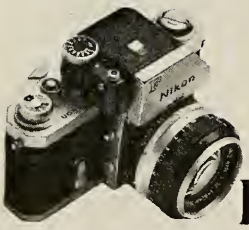

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When he got to The Bar they ga
him the shots, kept him in bed a f
hours, and let him go; and eig
days later he died in convulsions.

So as curiously uneventful as
own bite was remaining, and as ha
as the test directions were to re
Margie and I decided to hold off
treatment except the tourniquet a
the less heroic or more inescapa
ministrations of local well-wishe
until I could produce a sensi
symptom.

The only classic snakebite sym
tom I could come up with, howev
was fright; and as time passed ev
that began to wane a little. Or rath
I should say, divergent possibilit
materialized: either my sympto
were, for some reason, being po
poned or I had not got any pois
with the bite. As the minutes pass
the latter lost some of its sensel
sound, although in the predicame
we were in you can't afford to i
dulge in overoptimism. When it g
to be five-thirty and still no airpla
had come to take me away, Mark a
my son David poured diesel oil
all the cans they could find and o
lined the landing strip with the
against the unlikely arrival of so
wild pilot who would have no lig
to take off by.

As hope for getting me out wane
the bush medicine began to be ma
From the time I got into bed Sheft
had begun bringing coffee, made
the consistency of melted roofi
compound, and standing by to
sure I drank it before I began vom
ing blood. Margie loyally helped n
drink it, but as soon as a pot w
emptied Shefton brought more.
one return he handed me a foot-lon
tar-black rope of locally grown t
bacco, which he had kept under h
bed for three years against just su
an emergency as this, and anxious
insisted that I eat it. I gnawed off
small a piece as possible and u
happily started chewing it. Sheft
watched a while and went away, u
ing Margie to be sure I ate it a
Word of the accident had quick
reached the village two miles awa
and the first thought of Sibella Ma
tinez. my oldest Tortuguero frien
was that her daughter Junie, who w
washing clothes at the station, w
pregnant, and so a dire threat to n
existence. Any man, Sibella say
bitten by a *terciopelo* and seen by

Continued on page

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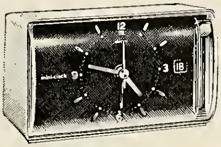

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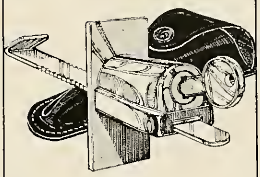

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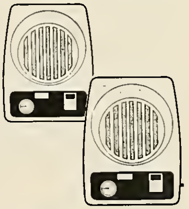

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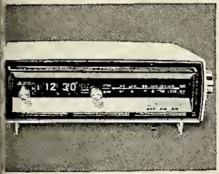

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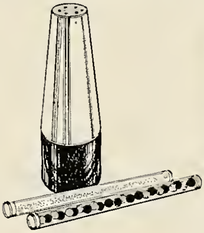

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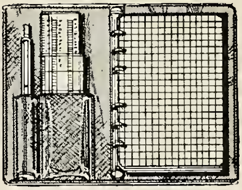

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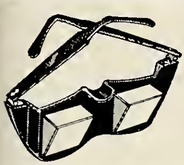

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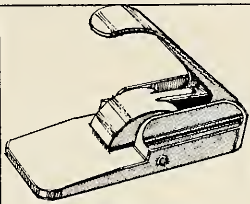

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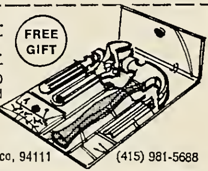

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Watching Seals at Turtle Rock

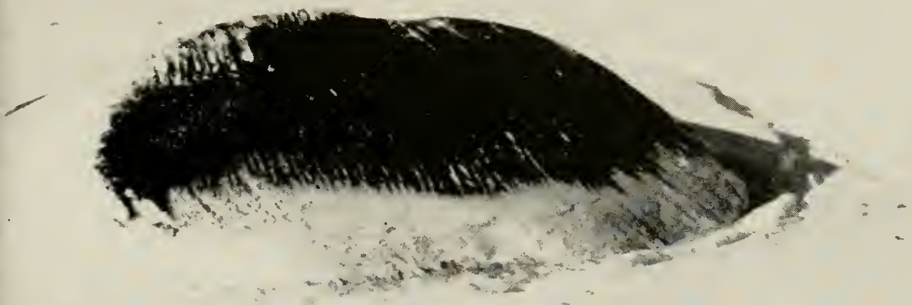
To best observe Weddell seals, become as much like them as possible—live in their colonies and swim with them in the freezing waters under the Antarctic ice

The roof of ice above was domed and undulating, hung with stalactites of ice crystals; the watery space, copper sulfate blue near the top, shaded off to black toward the depths. Seals glided by, chunkily torpedo-shaped yet sinuous, their big eyes gazing out, unblinking. Eerie chirps and sonic trills permeated the void like a musical score from another planet—composed, orchestrated, and performed by the Weddell seal.

We dived with these seals in a strange world under the six-foot-thick Antarctic ice in an attempt to integrate aspects of their underwater behavior with that we had observed on the ice above. We especially wanted to determine the function of the Weddell seal's astonishing repertory of underwater sounds: sharp whistles and "chinks," piercing trills, soft "too-loos," jaw claps, throaty "what-chunks." As these sounds seemed to be connected with social and reproductive behavior, we wanted to live within a rookery itself to study the seals 24 hours a day in their own environment of sea ice and the water below.

Early in October, 1966, the authors, with David O. Lavallee of the U.S. Navy, erected a camp seven mil northeast of the United States McMurdo Station, o the ice of Erebus Bay, 200 feet northwest of an is lated volcanic cinder cone called Turtle Rock. Its se colony, well separated from other rookeries, was sma and cohesive, allowing us to recognize individual seal Turtle Rock provides the two vital requirements of rookery: shelter from wind and access to water. Stee on its north and west faces, it has a broad, ice-covere plateau to its southeast. At the northeast corner of th island are a series of ice hummocks, which make e fective windbreaks for the seals that lie among them A crack in the ice, kept open by the two- to four-foo tides, approaches from the southwest, circles the ic foot on the north face, and extends northeast towar Mount Erebus. Along this crack seals gather, keepin their access holes open by persistently "sawing" wit their upper teeth through the soft ice that forms in th crack each night.

The first seals had already congregated on Turtl Rock's northwest side in the lee of the prevailing win



by Carleton Ray and Michael A. deCamp

en the serenity of their icy seascape was shattered a train of lurching Nodwell tracked vehicles, towing o plywood shacks across the ice toward Turtle ck, and by chain saws and dynamite making open- gs in the ice for diving holes. One shack was our me and a monitoring station for weather and under- ter sound; through its large window most of the okery could be observed. The other, with an open- g in the center of the floor, was positioned over a rresponding diving hole.

Divers are noisy and the severe cold limits their e underwater. In order to keep a constant watch d maintain the necessary quiet for recordings, an genious subice observation chamber (SOC) was ilt by the National Science Foundation from a de- n by David Lavallee. The SOC, a six-windowed, 6- 4-foot chamber on the end of a 12-foot access tube t ran down through the ice, was placed where the ter depth reached 25 feet. Just beyond the chamber, dark pebble bottom dropped precipitously at a 30- gree angle. From 80 feet downward, rocky outcrops formed substrate for the attachment of a reef community of startling beauty—yellow-orange soft corals, delicate brown fan worms, yellow sponges, and huge brown sea squirts. From the chamber we could watch the seals descend to the depths or glide up the slope across the shelf to the tidal crack and air.

The seals at the rock hardly appeared to notice us as long as we kept a distance of a few yards. Upon approach to ten feet, they rolled on their sides, waved a flipper as if in salute, made clucking sounds, or snapped their jaws, and if we came too close, humped off across the ice or slithered through the crack into the water below. Finally, both men and tractors departed, leaving the seals and the seal watchers to the silence and the wind.

The Weddell seal is the only marine mammal that can be easily approached and observed in its own realm. Antarctica has no terrestrial predators, such as the polar bear and Eskimo of the Arctic, and not even the predatory killer whale or leopard seal often venture into the Weddell's shore-ice habitat. The seals are therefore fearless, placidly accepting the presence of man as a seal watcher, in or out of the water. Further, the Weddell's necessity to return to an air hole in the ice makes its movements relatively predictable. This ice forms a stable platform on which stations can be set up within the seal's habitat. Most important, the subice water is the clearest in the world, with visibility up to 400 feet.

The First Dive

To best study the seals underwater, we became "seals," donning our "blubber"—foam neoprene suits—and compressed air tanks. On October 17, we made our first dive, dropping through a layer of brash ice to enter an alien world. The ice and snow above filtered out 98 per cent of the light, but our eyes soon became accustomed to the dusk, and we could see great distances in the transparent water. Knowing that the water temperature was low enough—28.6° F.—to freeze the moisture of our breathing to ice and clog our air regulators, we stayed close together, but the beauty of the scene was overpowering and numbed us to the cold and apprehension we first felt.

Crystals of ice formed on the black volcanic cinders of the bottom and broke away to drift slowly upward, sometimes carrying a pebble or two to the sea ice above. The bottom was sprinkled with spiny golden worms, fuschia starfish, spindly sea spiders, purple sea urchins, three-foot tan nemertean worms, and an occasional dusky fish. Overhead, the ice glowed a soft translucent blue-white, washed with the growth of microscopic yellow-brown diatoms. In the distance, the tidal crack etched a silver line in the ceiling of ice. Seals glided around us and gathered under the crack; our ears were filled with their trilling, whistling, and distant rumblings.

Suddenly a female seal approached and swam between us, inspecting cameras and masks, and bumping against us with an astonishing absence of fear. Around and around we whirled, our faces only inches from that of the inquisitive seal. She left twice to surface for air, but otherwise stayed with us for the entire half-hour dive. Upon ascending, we had confirmed that the seals could be observed freely underwater at their rookery.

The Yearly Cycle

On October 9, the first pup of the season was born at Turtle Rock. Peak pup production took place about the third week in October, and by mid-November, 47 fat, squirming pups with their mothers, 25 pupless females, and up to 13 males comprised the rookery population. Seals were all around us, lying before the picture window, literally underfoot as we made our daily rounds. As the pupping season advanced and the population rose, underwater sounds also intensified, indicating increasing social activity. Our hydrophone picked up a weird inner-space concerto—not only from Turtle Rock but from the other rookeries at Hutton Cliffs, Turks Head, and the Dellbridge Islands, up to ten miles distant. As we tried to sleep after midnight
dives, our hut often shook with the trilling of nea
seals, and we heard the breathing of others as they s
faced for air in the hole beneath our diving hut.

Weddell seal pups are nursed for about six wee
the first ones weaned about December 1, proba
after voluntarily deserting their mothers. They gr
astoundingly fast in that time; their birth weight
50-60 pounds increases to close to 300 pounds
milk that is 50 per cent butterfat (heavy dairy cre
has only about 35 per cent). The mothers lose ab
two pounds for every pound the infant gains, and
little in the first weeks of nursing.

There are good reasons for this rapid infant grow
Fat has to be accumulated quickly to give the pu
food reserve for its difficult first winter when it m
feed itself and learn about its environment. Seco
wet hair is not a good insulator, so the thick inf
lanugo fur must be replaced by a blubber layer, up
three inches thick in the Weddell, which keeps the s
warm during swims. In addition, a process known
vasoconstriction allows a seal exposed to the extre
cold of wind or water to shut down the blood sup
to this blubber, conserving vital body heat to keep
underlying flesh warm.

Presumably it is after mother–infant separation
December that the seals mate again, but to date
has not been observed. Beginning in that month
ice thaws and breaks up, and most of the seals retr
landward or to the shelf ice. Reproductive activity
creases, and by the end of December silence repla
cacophony underwater in Erebus Bay, and most se
spend their days basking on the ice surface.

During January, the warmest month, the wate
clouded by the growth of plankton and by silt brou
to the sea by thawing snow and ice on land. The
is high; the seals feed little and undergo their yea
molt. Both hair and epidermis are replaced, the c
becoming sleek and gray above and silvery bel
flecked with dark gray and white. The females h
been impregnated since December, but the nor
course of pregnancy is interrupted; the embryo h
in the Fallopian tube and remains dormant for a ti
In February, after the molt is completed and feed
is reintensified, the embryo descends, becomes
planted in the uterus, and grows for the remain
eight to nine months of pregnancy.

In March the sun descends, and the ice begins
form once more. Where the seals remain for the win
is not precisely known. However, we think that m
of them—at least those of the breeding population
stay not too many miles from their rookeries for
entire season, remaining in the water, vasoconstrict
for days or weeks at a time. They keep their air
access holes open, and when the pupping season
proaches the next October, the colony suddenly
appears as if from nowhere.

A Weddell seal can dive to nearly 2,0
and stay below for almost an hour
returning to a tiny air hole in

Weddell seals have no fear of man and
approach divers, above. At right, the
on the left assumes a subordinate
to escape molestation by a more dominant

Each day as we went from our hut to count the colony we found new pups all around us, but we had not yet been able to witness the birth of a Weddell seal. On one occasion, we noticed a large seal waving its flippers in the air and contracting its abdomen, but upon rushing out we discovered it to be a dreaming male. Later, we observed a female doing the same thing, but when we dashed out of the hut, we found she had given birth in the time it took us to travel the hundred yards to her side.

Birth of a Pup

On the morning of October 25, we began an around-the-clock birth watch and finally, late that evening, spotted a seal in unmistakable labor. In less than three minutes, we were on the scene with cameras, temperature probes, and a tape recorder.

The observed period of labor lasted for 27 minute
of which 15 were recorded on film. The mother lay
her side, head and rear flippers extended, occasional
twisting her hindquarters to and fro. During this p
riod there were twelve series of contractions, lasti
from 6 to 75 seconds, with intervals between ea
series of 4 to 83 seconds. During the last 70 second
the head and shoulders of the pup, encased in a pi
membrane, slowly emerged, advancing and retreati
with the rhythm of the contractions. With half t
body visible, the membrane broke, and all at once t
pup slid onto the ice, precipitated warm and soaki

curious pup gazes down through a hole in the e before taking one of its first swims.

wet into a world 102 degrees colder than the 99° F. within the mother's body. The mother whirled about, the force of her movement breaking the umbilical cord. Sniffing at the 4½-foot, 62-pound pup, which raised its head feebly, she commenced to bawl, a sound the pup imitated in weaker soprano. Thus initially by sound and smell, later assisted by sight, do mother and pup learn to recognize one another.

Seven minutes after birth the pup began to shiver as the moisture on its fur began to freeze, and its skin temperature fell to 77° F. Thirteen minutes later, it was only 70° F. However, as the moisture of birth froze to ice crystals and the pup continued to shiver and squirm, the crystals began to fall off and the pup seemed to grow before our eyes. The thick infant fur, lanugo, began to dry and fluff out, insulating and warming the skin. Forty-seven minutes after birth, with a few ice crystals still adhering to the now nearly dry lanugo, skin temperature had risen to 93.4° F. Transformed from a wet, weak newborn to a warm, wide-eyed, active pup like its fellows lying about on the ice, it located a nipple, extruded by a muscular contraction by the mother, and took its first meal.

From the beginning, it appeared to us that pups born early in the season into below-freezing weather had a higher survival rate, and grew both faster and to larger size, than those born later during warmer weather. At higher temperatures the moisture of birth does not freeze, and the pup remains wet and chilled. Without the "instant fur coat" of the dry, fluffy lanugo, the blubberless pup loses metabolic heat, undergoes cold stress, and may grow more slowly or even die.

The Weddell seal lives in the harshest environment on earth for a warm-blooded animal—the ice and polar sea beneath. It is not the coldest environment in terms of absolute temperature—the air temperature above the Ross Sea in winter rarely falls below –60° F. or below –20° F. in the spring, and water temperature in both seasons remains at its freezing point of 28.6° F.—but it is one in which heat loss can be extremely severe. Wind, moisture, and radiation are more realistic parameters of animal comfort than air temperature alone, and may be expressed as a "chill factor," or "temperature-humidity index" to measure the heat loss or gain to which an animal is subject. For example, on a day when air temperature was 0° F., a "black body" (a measure of radiative heat equivalent in this case to a seal's fur) might register 20° F., but with a 25-knot wind blowing, an unsheltered seal would experience an effective temperature of —25° F., 45 degrees colder than a seal among ice hummocks out of the wind. In addition, a wet seal is subject to the unremitting cold of a highly heat-conductive medium: water at its freezing point is 23 times as efficient as air as a conductor of heat.

'Sawing" at the soft ice in the tidal crack vith her upper front teeth, a female opens n access hole while her pup looks on.

In order to discover the effect of the wind and cold on the subsequent survival of the pups, we tagged, measured, and weighed the first 25 born at Turtle Rock, and charted their movements daily. Most of the mothers showed a marked tendency to remain in restricted areas, and exhibited a zone of interference, a radius of ten feet or less, within which other seals were not tolerated. The earliest to arrive at the rookery had chosen the most sheltered spots, which lay at the northeast corner of the rock or among the hummocks. During winds or storms, mothers and pups in the lee were protected, becoming drifted in by the blowing snow. Late-arriving females, lying in the open, were protected from wind to a lesser extent, and we felt that the pups thus exposed were inhibited from feeding sufficiently during storms. The telltale effect was that pups in the lee grew to 240-260 pounds by the age of four weeks. Pups in the open grew to a maximum of 190 pounds in the same time. This difference could spell winter survival to a pup that must fend for itself from December onward.

Familiarization with the Underwater Environment

At night, when the sun is low and the temperature drops, the colony becomes more active and the mothers often take to the water. After the first week of life, the fattening pups may enter the water out of curiosity, or in response to the calls of their mothers', who, half-submerged in holes in the ice, encourage the pups to flop into the water by bawling to them. Mothers usually remain with the pups, enlarging the holes by "sawing" from side to side with their prognathous upper teeth. By the time the pups are two or three weeks old, they are swimming under the ice to neighboring holes or diving ten or fifteen feet to the nearby bottom. As the pups become more venturesome they swim out under the ice many yards from the nearest air hole.

As far as can be determined, the mothers make little attempt to teach their pups to swim or find their way about. However, a pup struggling to emerge onto the slippery ice was often bumped and nudged to the surface by its mother.

Senses and "Song" of the Seal

When a seal enters the water, it carries with it the normal complement of mammalian senses, but all these, except hearing, have minimal efficiency underwater. There is no way a mammal can use its sense of smell without breathing. Sight is limited by the clarity of the water, which allows visibility up to 400 feet, a short distance for a Weddell seal, which may travel two miles or more on a single dive. Taste and touch are useful only at close range or in actual contact. However, since sound travels both faster and farther in water than in air, aural communication becomes of paramount importance for these marine mammals.

Presumably the seals use sound to echolocate food in the black of the deep sea or in the 24-hour darkness of the austral winter. The Weddell may also use "sonar" to navigate from the depths to find his tiny but essential air hole.

With the aid of sophisticated electronics, we know that the Weddell seal is one of the most vocal of mammals underwater. Our observations have shown that the majority of its astounding array of sounds serve in some aspect of social or reproductive behavior: the calling between mother and pup; the male–female courtship and threat; and the "song" of the male. This term has been reserved for the stereotyped, repeated territorial call of birds, frogs, toads, and certain insects, and heretofore has not been applied to mammals. But the long trill, acoustically analyzed by William E. Schevill and William A. Watkins of Woods Hole Oceanographic Institution, really is a song, and its purpose seems to be to maintain dominance within a given territory.

Studies of pinniped sound reveal that most social species are highly vocal; the most silent, like the timid little Arctic ringed seal, are the most solitary. Perhaps the complexity of acoustic and social behavior evolved together in seals as in primates.

Life of the Rookery Males

There were never more than thirteen males at Turtle Rock but they made little attempt, if any, to consort with the females while on the ice. Most of the males were cut and bleeding about the neck, chest, flippers, penis, and belly. Their manner offered little improvement on their appearance; they reacted to a human intruder in a nervous, shifty manner, unlike the placidity of most of the females and the curiosity of the pups. Occasionally, as we approached a sleeping male on the ice, we heard an entire repertory of trills, whistles, chirps, and cheeps—the same sounds we heard underwater. Males away from the rookery were rarely so mutilated, nor did they appear so mentally active, suggesting that rookery males are the dominant breeding individuals, which have won and which defend this privilege.

From the SOC we observed some seals descending purposefully to the bottom, presumably going to feed on the nototheniid fishes that comprise the major portion of their diet. Others seemed merely to be passing the time; almost from the beginning we recognized some of the latter as males. One in particular bore a large white splotch on his right flank, and his manner indicated a certain dominance. Other males avoided him, swimming rapidly through the area where he drifted casually; occasionally he gave chase. Frequently he circled out over the deeper water, posed vertically to the bottom, and drifted with rear flippers undulating slowly. Then he uttered the piercing trill, which descended to end in powerful "chugs" that we had recorded so often, and swam slowly back up to the crack. This trill was repeated in a stereotyped fashion and appeared to be a territorial display. However, other males shared this "territory," and when we donned diving gear to investigate, we discovered that each male had his own special place. For instance, one of them, when in the presence of the dominant male, swam rapidly to a crevice under the ice foot of Turtle Rock and posed with foreflippers at his sides, eyes popped wide, and head drawn sharply back. In this submissive posture, he was not molested by the dominant male.

Top: as labor nears its end, the pup'
head emerges; the enclosing membrane rupture
and the pup slides onto the ice, top right. A
center: the mother sniffs at her still-we
newborn, left, and bawls to establis
aural recognition, right. Bottom: the now-dry pu
nurses at a nipple "popped" out by the mother

We saw no fighting at Turtle Rock; apparently the hierarchy of dominance was already sorted out. In earlier years we had observed males circling each other in the water, seizing one another's throats, and twirling and tumbling until one broke free and retreated. Such fights were responsible for the cuts seen on the forequarters of the rookery males and, we presume, established the peck order we observed.

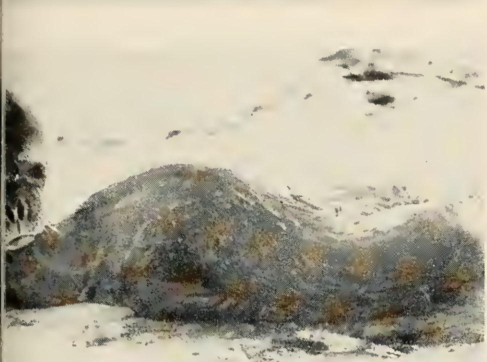
Courtship

Between his territorial trilling displays, the dominant male tried to approach the females and pups gathered along the crack. He called to the females in broken trills, chugs, and what-chunks, but never used the long trill we heard from the SOC. The females generally ignored him or swam slowly away. Sometimes the pups, in a commotion of agitated foreflipper waving, impeded his approach. If he came too close, the females warned him with throaty chugs or sharp jaw claps; and if he persisted, chased him off, biting him on the rear flippers, penis, or hindquarters. It was clear that while the mothers were still accompanied by the pups, there would be no copulation. As mentioned before, this probably takes place underwater sometime in December, but has never been observed.

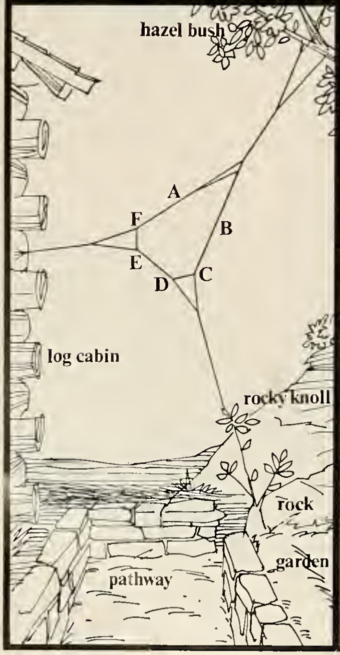
For the Future

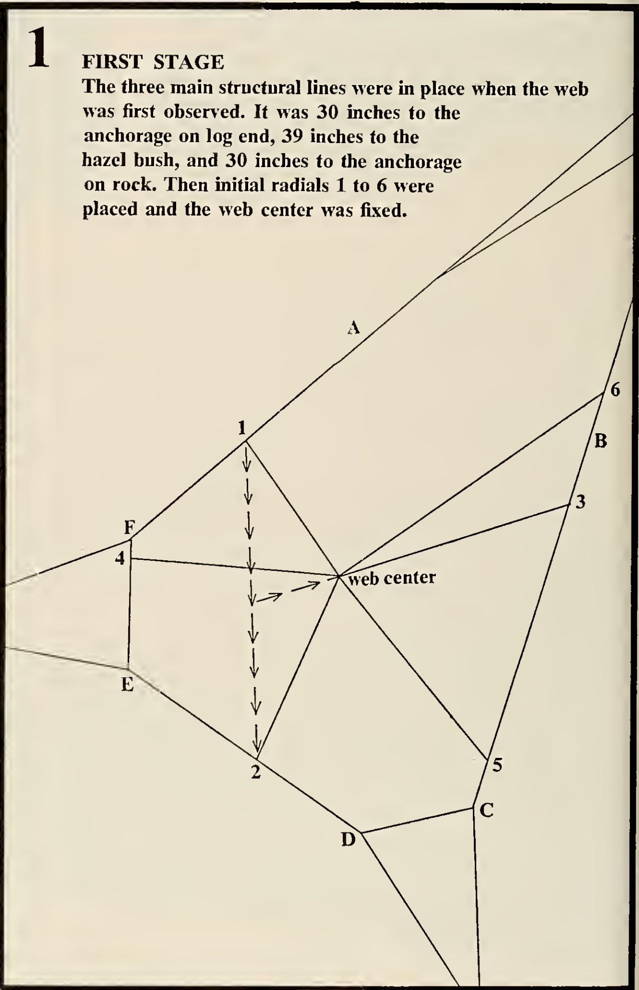
Weddell seals, alone among marine mammals, have been visited intimately in their own dual world by man for long periods of observation. We have lived in their rookeries and have swum with them below the ice. The results of this research, and of other projects in Antarctica, are that this remote species, an outpost of life in an often desolate and terrifying, but beautiful land, is perhaps the best understood marine mammal in nature.

We would still like to know how the pups learn about the deep sea; how Weddell seals spend their first winter; and most compelling of all, how they find their way to a tiny life-giving hole in the ice, which they cannot see from the depths or in the dark of Antarctic night.



The Weaving of an Engineering Masterpiece, a Spider's Orb Web, Done at Fayson Lakes, N.J., August 8, 1942, as Observed and Reported by B. E. Dugdale, Structural Engineer


hazel bush
A
F
B
E
D
C
log cabin
rocky knoll
rock
garden
pathway



1

FIRST STAGE

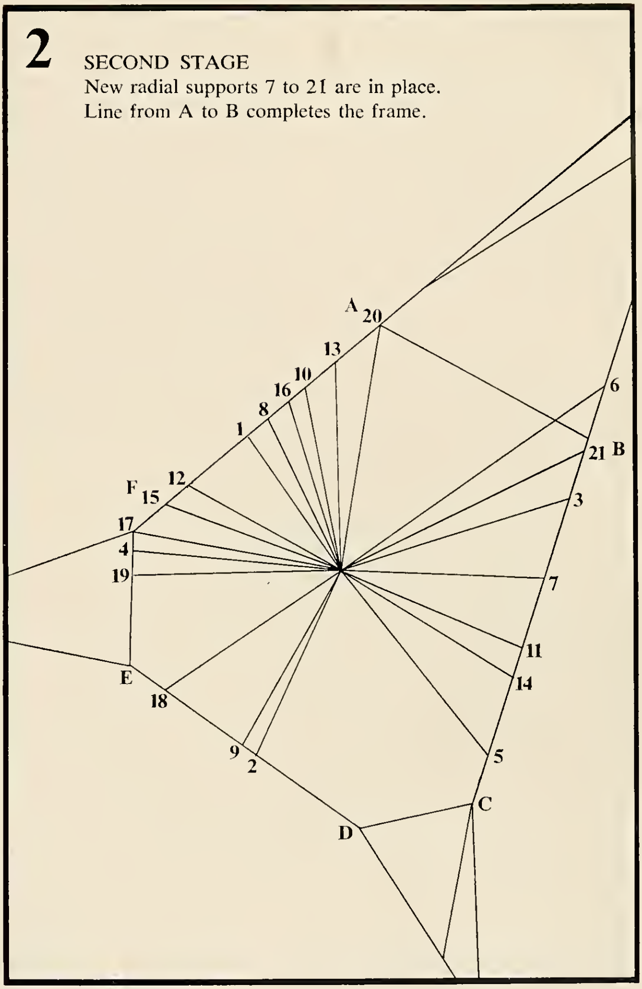
The three main structural lines were in place when the web was first observed. It was 30 inches to the anchorage on log end, 39 inches to the hazel bush, and 30 inches to the anchorage on rock. Then initial radials 1 to 6 were placed and the web center was fixed.

A
1
6
B
3
F
4
web center
E
2
5
C
D

Early one morning in August of)42. at Fayson Lakes, New Jersey, ı opportunity came to me that I had atched for, but missed, for many ears. A spider had just completed acing the structural supporting ıes for a web. Realizing that this as my opportunity to study the step- /-step construction of a spider web, hurriedly assembled my drawing ɔard and paper, my pencils, and a x-foot rule, so that I could record ; carefully as possible the steps to ɔmpletion. My chair was placed so at I was about an arm's length from e weaver as I watched it.

As the spider added new elements the web, I added corresponding ɜw lines to my sketch, along with ɔting the order in which the lines ere being made. The spider kept e busy indeed, and I had little time ponder the engineering significance of what it was doing. After ɔth of us were through with our ork, we each went about our own fairs. The sketch eventually ended ɔ in my filing cabinet at home. wenty-three years later, in the ɔurse of shifting papers, I found it gain, and it fascinated me. I began otting the stages of that spider's ork on different sheets of paper, ıd only then, as step-by-step I aced what it had been doing, did I ɜgin to realize the full significance ' the pattern it had followed—a pattern corresponding to a detailed blueint that left little to chance.

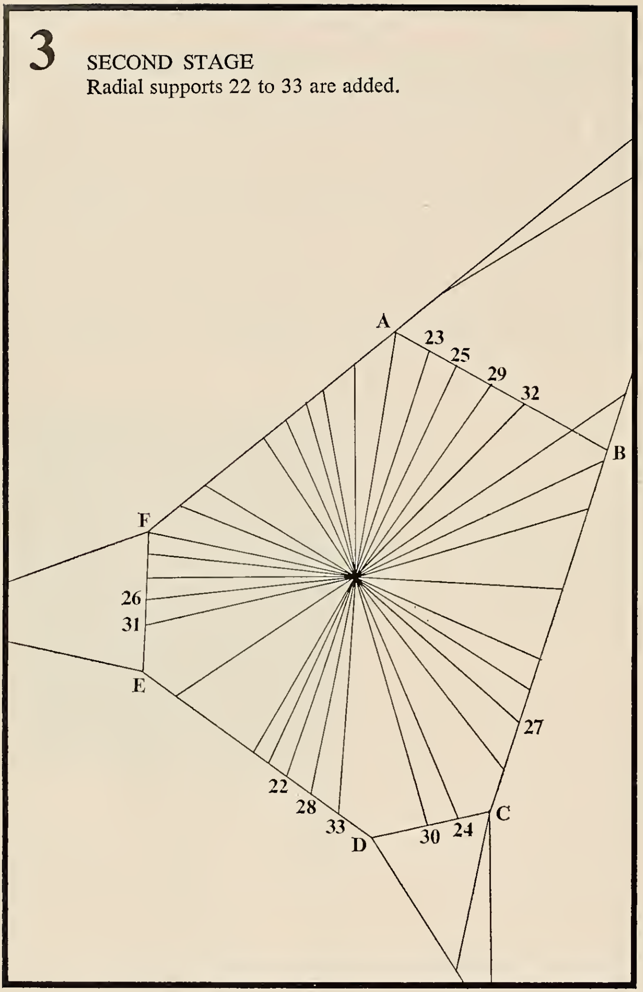
The drawing at the left shows here the spider had worked, alongde my family's log cabin, one of veral inhabited by nature-loving ıcationers in summer. About six et from the corner of the cabin was rocky knoll, with a small bush ɔrouting out of a crevice in the rock. branch of a larger plant, a hazel ısh, reached over the knoll toward e cabin. Between the cabin and the ıoll grew a small patch of wild ɔses, daisies, asters, and other wild, oodland flowers in their season. It probable that the protection proded by the overhanging eaves of e cabin, the presence of the prouding corner logs, the pathway beeen the cabin and the wild flower ɜd, and the stone steps leading up the rocky knoll all combined to oduce an ideal location for an orb-weaving spider to set up housekeeping. Many times, over a span of several years, I had seen orb webs suspended almost vertically in this exact location, and I had watched numerous spiders of several species carrying on various stages of web construction there—indeed, I had often walked into these webs while fetching firewood. It is also probable that on that morning the favorable air currents around the cabin, and the prospect that insects attracted by the flowers would fly head-on into the hanging web, were bonus inducements that caused one *Micrathena gracilis*, an orb-weaving spider, to start spinning its silken lines. Of a species reported to be widely distributed in North America, it was grayish in color, about one-quarter inch in length, and its abdomen was armed with distinctive spines as well as the more conventional pairs of appendages called spinnerets. It is through these organs that spiders excrete threads of silky material.



2 SECOND STAGE
New radial supports 7 to 21 are in place.
Line from A to B completes the frame.

CONSTRUCTION PLANS

The entire process took about two and one-half hours and consisted of


3 SECOND STAGE
Radial supports 22 to 33 are added.

four stages, which can be described as follows:

First Stage: Placing structural supporting lines to provide a triangular-shaped framework for the web, which would itself be roughly six inches in diameter (Drawing 1 shows the scene when first observed, and the establishment of the web center).

Second Stage: Completing a system of radial lines to connect the web center with the surrounding framework (Drawings 2 to 4).

Third Stage: Building a temporary scaffolding spiral, extending from the web center to the outer frame (Drawing 5).

Fourth Stage: Installing the final viscid spiral webbing and removal of the scaffolding (Drawing 6).

Construction Details

Stage One (Drawing 1): When I first observed the web, it already had the three main supporting lines, with crosslines C-D and E-F in place, thus completing the polygonal, outer web framing, BCDEFA (except for a crossline between A and B, which was not placed until later). The spider had also reinforced each main structural line by traversing it from time to time, adding a new strand on each passage. These strands fanned out at the anchorage points to provide multiple attachments (a common human practice when anchoring the cables of a large suspension bridge).

The spider now proceeded to establish the web center (Drawing 1). First, it attached a free-running line at point 1 on AF; then, moving through point F down to ED, it attached the other end at point 2. A quick movement of the spider's spinnerets fastened the line sufficiently well. Now it moved up this line and approximately midway between 1 and 2, attached one end of another line. Again spinning out a line as it went, the spider carried it down to 2 and then along DC to line CB where the other end was attached at point 3. This time the line was pulled taut before it was attached. It was this pull that brought radial lines 1, 2, and 3 to the positions shown on Drawing 1. The conjunction of these first three radials determined the web center, which was then stabilized by the placing of radials 4, 5, and 6.

The web frame, with the initial radials 1 through 6, was not in a completely vertical plane; it was inclined about 15 degrees off vertical, with the upper part leaning away from me. I was not sure on which side the spider would operate, but inasmuch as viewing was most convenient with my back to the sun, all my observations and sketches of the web were made with the spider working from the other side. This was fortunate. As the weaving proceeded, my position afforded close-ups of the weaver's use of abdomen, legs, mandibles, and spinnerets.

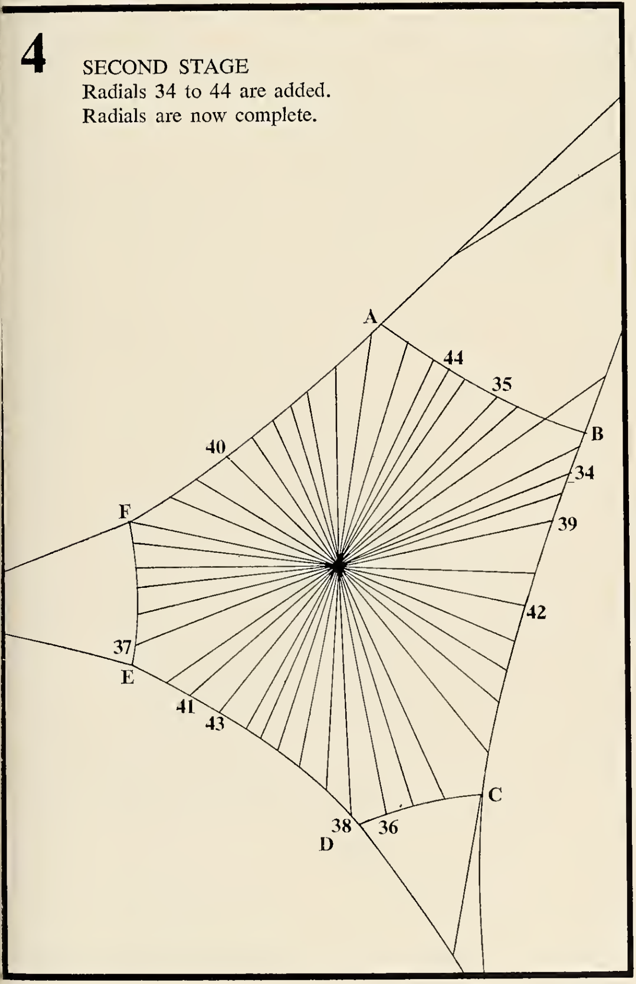
Having now established a web center the spider proceeded to the second stage of construction.

Stage Two (Drawings 2 to 4): A complete system of radial lines joining the center point to the several enclosing framework lines was now put into place.

The method of installing the additional radials was like that for the initial radials, 1, 2, and 3, except that each new radial was first attached to the center and then carried to a selected location on the enclosing ame. The spider was adept at hold-g a hind leg high and keeping the e-running line from becoming en-agled with existing lines. The fact at the spider was working on the derside of the off-vertical web may ve helped, as gravity would tend draw its body and the free line ay from the web plane.

If the reader will run his eyes over e radials in their numerical se-ence, starting with the three initial es, he must be impressed by the ct that never was a new radial aced adjacent to one just laid, but ways at a distance from it, so as to continually equalize the tensions on the system and thereby maintain the location of the web center. Otherwise, because of the elasticity of the fibers, the center would have constantly shifted to new points, and the polygonal form of the framework would have assumed ever changing shapes and distortions.

Drawings 1 to 3 show the structural frame as straight lines. This was not actually the case. As each new radial was attached to a frame line, the tension placed upon that line caused it to deflect to a more curved line. For convenience in field sketching, I kept the straight-line form for the frame, until all the radials were placed.


4 SECOND STAGE
Radials 34 to 44 are added.
Radials are now complete.

When radials 20 and 21 were placed, there was as yet no cross member from A to B. The spider, after placing 21, went back down it without hesitancy, up 20 to A, then returned the same way with a running line that became crossline AB and was attached to radial 6 at their intersection point. The full polygonal frame, ABCDEF, was now complete, and other radials could be attached to AB.

It is of interest to note that during this selective method of locating the radials, in only one instance was a new one anchored too near an existing radial, and that was 22, adjacent to radial 2. In a few cases there was too much space between radials. In each case the spider later filled the gaps with partial radials.

That an apparently deliberate method was used by the spider to maintain the approximate web shape established by the first six radials is suggested when the next eight radials are studied (Drawing 2). Lines 8, 10, and 13 are well dispersed between points A and F, and radials 7, 11, and 14 are similarly spaced between points B and C. Further evidence of deliberate planning at this stage is seen in the placing of numbers 15 through 21. Again, in Drawing 3, one sees that tensions on the center of the web remain balanced by the spider through its choice of radial locations for lines 22 through 33. With so many radials now in place, further care in spacing would not have been necessary, yet the weaver continued its careful selection of locations as radials 34 through 44 (Drawing 4) were added.

Stage Three (Drawing 5): With all full-length radials in place, the weaver proceeded with the next item of construction, the scaffolding, which would be removed after serving its purpose. It consisted of a spiral starting from the center and continuing to the outer perimeter of the web.

The first seven circuits of the spiral were spaced very closely, about 1/32″ to 3/32″ apart. The next four or five were spaced 1/4″ to 5/16″ apart, and the balance of the circuits averaged 3/8" apart. To maintain an even spacing the spider kept a foot on the preceding circuit as it hurried around the web.

Several interesting examples of what appeared to be decision making occurred during this stage. At a few places where radials were too far apart and the spider would have to stretch to reach the next one, it discontinued the spiral and installed a partial radial long enough to reach the outer frame, and held in place by existing scaffolding. The partial radials are marked X on Drawing 5.

Again, when the spider had run the scaffold line to the outer end of radial 14 on what could have been the last lap, it immediately reversed direction, and made a full circuit, terminating the scaffold line where radial 11 joined the outer frame.

It is at this point that the spider began the final stage of construction—spinning the viscid, or sticky, webbing, while simultaneously removing the scaffolding. The purpose of the stickiness, of course, is to trap prey for the spider. The viscid filaments are so effective that insects, once enmeshed, seldom escape. The spider, which itself may be bothered by the adhesive, exhibits much dexterity in running about the web without getting into trouble.

When constructing the web, it can exude either dry or viscid fiber. The dry is used for all purposes except catching victims. In the first three stages of construction, every filament was of the dry, non-sticky type. I know this because I repeatedly tested the lines for adhesiveness.

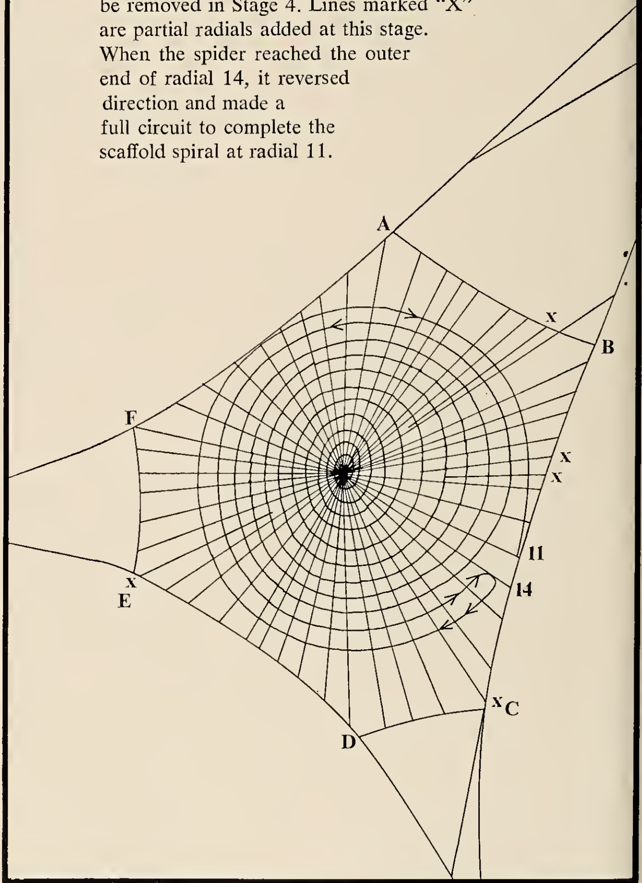
However, the filaments may vary in makeup. The spinnerets of the spider can be controlled to produce either round, dry lines, each comprising a bundle of several strands held together as a unit, or a flatter, ribbonlike line. Sometimes the dry line may have a succession of sticky beads. But this is a special case. Observers have found that there is a viscid layer on such a filament when it is emitted, but the layer then forms a succession of beads.

Stage Four (Drawing 6): We have seen that the spider terminated the scaffold spiral at radial 11, after having reversed direction at radial 14 the previous time around. Whether planned or not, this reversal served a useful purpose, for without a second's hesitancy the weaver proceeded to spin the viscid spiral, this time starting from the outside, instead of from the center. During this final phase of construction, the spider had better footing than previously; it could step on the dry scaffolding lines as well as the radials. This does not mean that the viscid spiral conforms exactly to the contour of the scaffolding. Several circuits of the viscid line were made for each circuit of the scaffold.

As the viscid fibers were indistinguishable from the scaffold fibers by sight, it was difficult, while making Drawing 6, to discern the scaffold lines in areas where they were crossed or overlapped by viscid lines. Only later, in the final moments of the spinning, did it become clear that the scaffold lines were gone. When the spinning was completed a ball of white material was visible at the center of the web. This material the spider consumed. Theodore Savory, in his *The Biology of Spiders*, informs us that as the viscid fiber approaches the next turn of scaffolding, that turn is rolled up by the spider;

5

THIRD STAGE
Scaffolding is a temporary spiral that will be removed in Stage 4. Lines marked "X" are partial radials added at this stage. When the spider reached the outer end of radial 14, it reversed direction and made a full circuit to complete the scaffold spiral at radial 11.



us accounting for the accumulated ıll at the finish.

Different species of spiders have ıaracteristic patterns for their web :nters. *Micrathena gracilis,* after ınsuming its discarded scaffolding, :tually cut out the center area of e web to provide an opening rough which it could come out on ther side of the web. The diameter ' this opening was such that the spi- ɜr's eight legs spanned the gap ithout difficulty.

After two and a half hours of eady work, all was completed; the ɔuse was ready for occupancy. The ıider then took up its position over .e center opening (about one-half ·ch in diameter) with legs spread ıt upon the radials. It was now ·ady to detect any vibrations that ould indicate that a victim was apped and would also give its lo- ıtion.

The Spider as Engineer

The term "engineering master- ece" in the title of this article is ore applicable than one might sup- ɔse. The use of three main struc- :ral supporting lines is an en- neering technique based on the ɜometrical proposition that it takes ıree points to determine, or stabi- ze, a plane. Also, the triangle is the ısic form used in construction to ·cure stability and equilibrium.

The division of the web-weaving :ocess into four separate steps close- reflects similar procedures in the ɔnstruction of a building:

1. Laying the foundation.
2. Placing the structural frame- ork.
3. Building the scaffolding for en- osing the structure.
4. Preparing the place for occu- ıncy, and removing the scaffolding.

After construction, the spider will ıntinue to have engineering prob- ms, but now under the heading of Repairs and Maintenance."

It was hard not to think in human rms as well as strictly engineering rms when contemplating the events this place. These questions oc- ırred to me:

1. Why was it that so many webs ıd been constructed at this same cation, the various spiders taking lvantage of the same existing cabin gs, tree branches, protruding rocks, etc., to build above the little wild garden? Are spiders able to stand off far enough and in some way survey all the attributes of a possible web site?

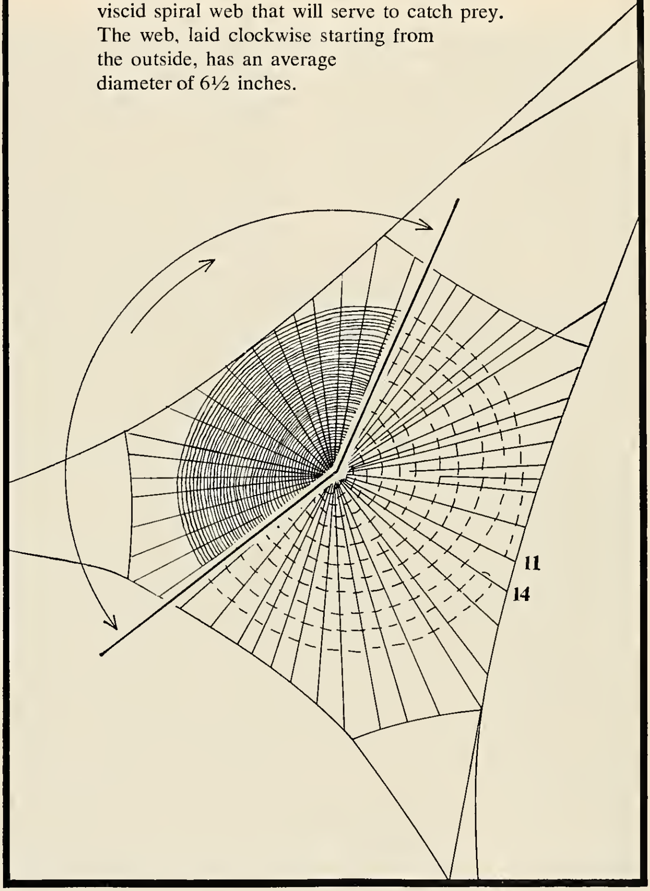
2. Having selected a site, can the spider then determine which of several logs, branches, etc., would be most suitable for anchorages?

3. Can a spider, having established a line from the end of a certain log to a branch, say six feet distant, then use some decision-making process that eliminates several alternate possibilities in favor of centering the web directly above the pathway, where insect traffic will be heaviest?

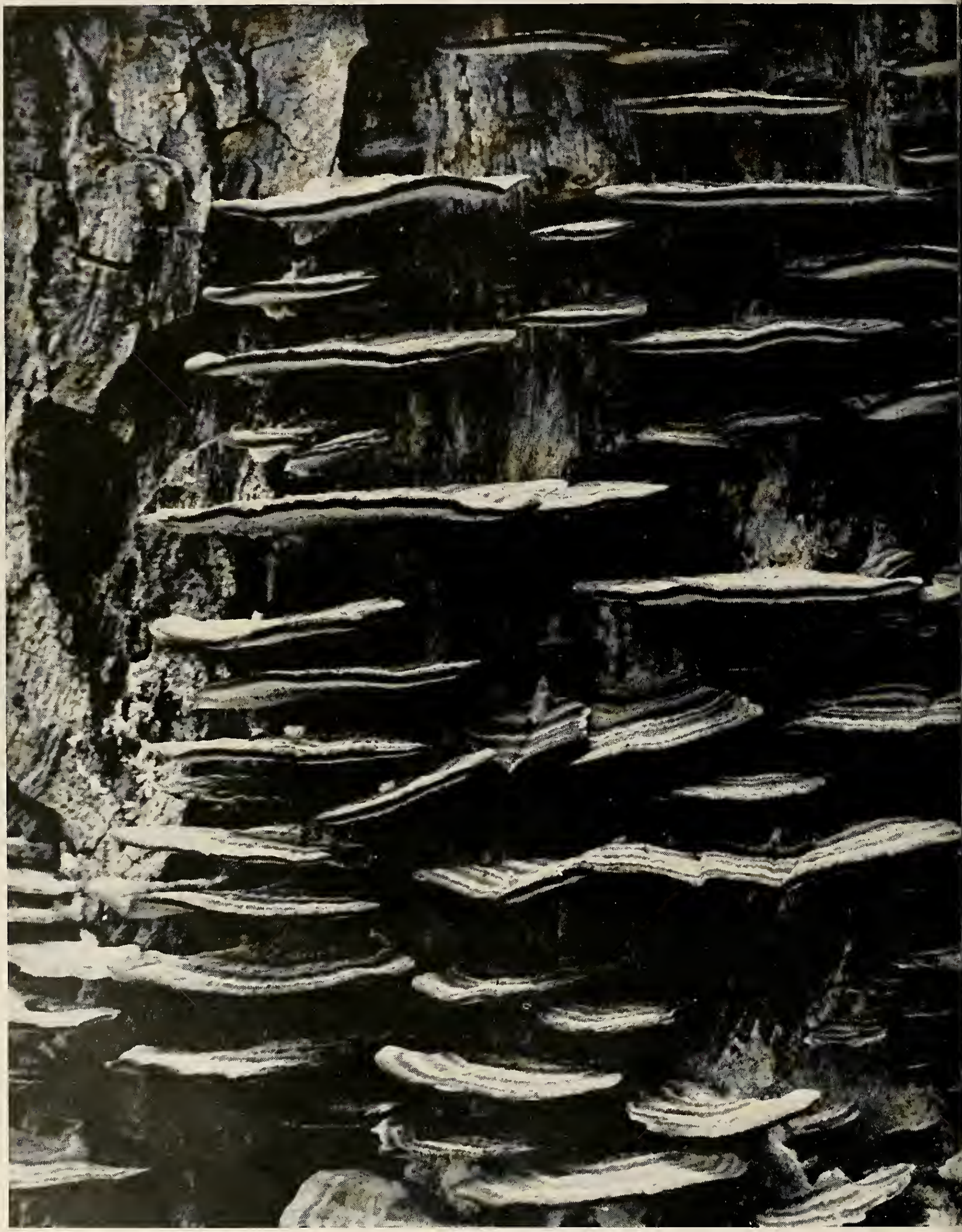
These and many other questions are unanswered, as far as I have been able to discover. I myself have no answers but it is my belief, based on many years of observation, that scores of spiders, of various species, have built webs at this site in a manner that suggests that the answer to these questions could be "yes."

At least, I can say that the same structural problems had been faced by innumerable builders, and all had been solved in the same competent manner.

6 FOURTH STAGE
Scaffold completed, the weaver now installs viscid spiral web that will serve to catch prey. The web, laid clockwise starting from the outside, has an average diameter of 6½ inches.



The Death and Decay o



rees

by Alex Shigo

Trees are superior organisms. They live longer and grow larger than any other living thing. But despite their fine adaptation to life on this planet, and their attributes for longevity, they too, like all organisms, die and decay.

It is primarily the resistance of trees to death and decay that makes them superior organisms—for while tissues in the center of a tree may be decaying, new ones are forming beneath the bark.

A major portion of the decomposition within a tree results from a great number and variety of microorganisms, mainly bacteria and fungi. In both size and longevity these are the opposite of trees; their life-span is measured in days, and their size in thousandths of an inch. But without them no organic matter would decompose. there would be no reuse of once-living materials, and thus, no continuation of life.

The struggle that takes place between a tree and the collection of microorganisms that break it down is generally similar for all tree species but differs significantly in its specifics. Our knowledge of this subject is most complete in the case of the northern hardwoods: American beech (*Fagus grandifolia* Ehrh.), paper birch (*Betula papyrifera* Marsh.), yellow birch (*B. alleghaniensis* Britton), sugar maple (*Acer saccharum* Marsh.), and red maple (*A. rubrum* L.).

The wood of these deciduous hardwoods is diffuse-porous: the fluid-transporting vessels are open-ended and are distributed evenly throughout the wood tissue. The wood tissues formed early in the growing season differ little from those formed later; as a result the annual growth rings are not distinct. The wood is normally bright white, heavy, and hard.

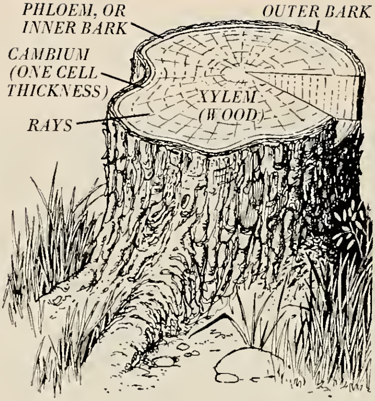
A tree should be thought of as a multiple plant, rather than as a single one, for the cambium—the tissue of one-celled thickness between the interior wood and the bark—produces a completely new set of wood tissues every growing season. In a sense, a new tree annually envelops the old. On the inside of the cambium, wood cells (xylem) are created, forming annual growth rings. Water moves mostly upward in these, carrying minerals from the soil. On the outside of the cambium, phloem cells are formed, carrying food produced by photosynthesis downward into lower portions of the tree. Each growth ring made up of xylem tissues can be thought of as an individual plant. Phloem is frequently described as an "inner bark," lying between the cambium and the outer bark, or "cork."

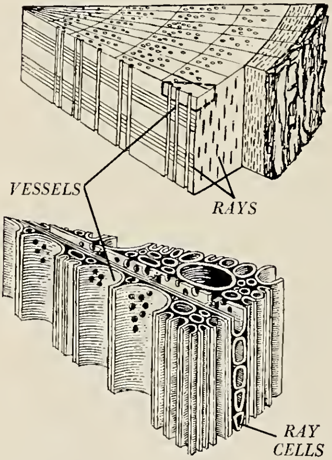
Plants can be vigorous or weak, depending on environmental conditions during their development. Thus, growth rings differ in thickness from year to year. Thick growth rings form during those growing seasons when conditions are favorable, while thin rings form during periods of stress. As the older wood cells near the center of the tree age and die, new, young, and vigorous tissues form beneath the bark.

In addition to the concentric growth rings, rows of living cells (rays) radiate from the center of the tree, like spokes in a wheel, transporting food materials and connecting the growth rings to one another. Groups of wood cells are bounded on the inner and outer sides by the thick cells of the growth rings, and on the sides by the ray cells. The physical strength of these living cells serves as a barrier to the decay process.

Bark also protects a tree from the physical processes that initiate decay. On some trees, such as the giant sequoias, bark is even fire-resistant. But if the bark is broken, a chemical system takes over, forming a protective barrier around the wound. The fact that these protective mechanisms function well most of the time is largely responsible for the longevity of trees. When a leaf falls, a branch dies, or a wound is inflicted, the openings generally heal and the protective covering of the tree is re-established. When the barriers do not function properly, disease-causing organisms may enter the tree through openings in the bark either above or below the ground.

Diseases cause more damage to trees than other destructive agents such as fire and wind. And, from an economic standpoint, the impact that disease makes on the growth and quality of wood, and on the general health of the tree, is even more important than the direct mortality caused by disease microorganisms. But since a tree is made of many sets of tissues, it is possible for one portion of a tree to be in a healthy state while other portions are retarded in growth, discolored, or decayed.





The wood of the northern hardwoods is "diffuse-porous." The vertical fluid-conducting vessels are distributed more evenly throughout the wood than in "ring-porous" species in which the vessels are clustered close together to form distinct annual growth rings. Northern hardwoods do not contain the darkened central core of dead heartwood cells found in ring-porous species. Instead, darkened cores in diffuse-porous species are the result of wounding and the invasion of microorganisms.

The question of how trees become diseased through wounding served as the basis for the science of forest pathology, which came into being almost a century ago during the most turbulent period in the natural sciences. In the latter half of the nineteenth century, the theory of spontaneous regeneration—that life originates from non-living materials when conditions are proper—was replaced by the germ theory—that life begets life and that microorganisms are responsible for certain diseases and decay.

In tune with the times, Robert Hartig, forestry professor at the University of Munich between 1870 and 1900, published several papers noting that fungi caused decay. His work upset the belief of the old school of spontaneous regenerationists within the forestry profession, who felt that decay caused fungi. A simple reversal of words formed the basis for the new science of forest pathology.

The science grew rapidly. But from then until now, Hartig's original concept of decay—that wood deterioration followed after a fungus entered a fresh wound—has changed little. Now this concept is being expanded to include the response of a tree to wounding, and the role of microorganisms other than decay fungi, namely, bacteria and non-decay fungi. We are attempting to show the sequence of events in the decay process and the successions of organisms that follow wounding, resulting in discoloration and decay of wood in living trees.

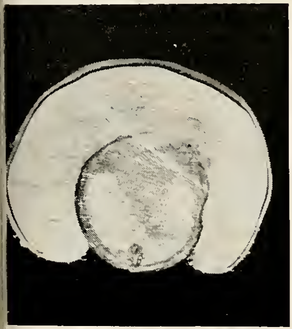
Wounding is the first step in this sequence. This may occur in one of several ways: Fire may burn the bark; wind, snow, and ice may break branches; sapsuckers and squirrels may attack to feed on the sap; insects may bore into the wood; and animals such as deer may eat the bark. Per-

is is a cross section of an wounded sugar maple, a ffuse-porous species. Annual igs are poorly defined and artwood is absent.

ps most wounds are inflicted by n, with his logging operations, hway construction, and a multi le of other activities within for- ed areas.

When a wound is inflicted on a e, some cells are killed, and others injured to various degrees. When od tissue is exposed, many micro- ganisms soon find their way to the ist wound's surface. Tiny bits of fungus and bacteria are in the at all times, and hundreds of dif- ent microorganisms may settle on injury. Of this number, maybe half will begin to grow, competing against one another for nutrients and space. The number of microorganisms able to survive under the existing conditions is reduced considerably within a matter of days.

iscolored core in this diffuse- rous hardwood is a result wounding. Wood formed ter the wound remains clear.



Of the few species that survive, even fewer are able to infect (begin to digest) the wood, for a tree forms chemical barriers to infection, phenols, that kill the organisms falling on the wound. Invading organisms must be able to gain food from those cells whose contents have been altered from their healthy state either by the wounding process itself or by the tree's response to wounding.

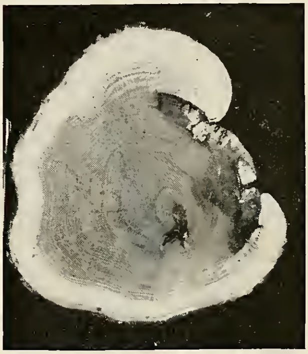
With most trees, the original infecting organisms are not decay fungi. The pioneer microorganisms that infect wounds are usually bacteria and non-decay fungi (Ascomycetes, Phycomycetes, and Fungi Imperfecti), which are able to utilize the food materials in the chemically altered cells. Normally, the resistance of the tree is greater than the infecting force of the microorganisms and these pioneer bodies make little headway, even though they have infected the wound.

When a tree is low in vigor or when a wound is particularly severe, the struggle for survival begins to bend in favor of the invaders. As a tree gets older and larger, for instance, its demands for space and nutrients increase: but it is a prisoner to its location. Often in this situation, trees compete with their neighbors, and all begin to weaken. In other cases, constant wounding over many years places too great a burden on the tree's repair systems or the tree may be weakened by man's activities—pollution, construction, logging, and fire. In time these stress factors accumulate, and the tree begins to lose its ability to protect itself.

When the microorganisms begin to utilize and degrade the chemical barriers formed by the tree, invasion —penetration of the healthy wood cells—begins. The microorganisms (now including decay fungi) competing for this new food source interact among themselves and with the exposed wood, resulting in an ever changing environment as the invading organisms move deeper into the tree.

As the process goes on, the cambium continues to form new tissues. However, when a wound occurs, the xylem tissues formed by the cambium during the following year's growing season are different in many ways from tissues formed normally: these new xylem cells have thickened walls, more cells are formed with living materials in them, and they are arranged differently.

These and other related changes result in a new barrier wall between the microorganisms in the older tissues and the newly formed tissues.



Cross section through a red oak, a ring-porous species, shows darkened heartwood and distinct annual rings. A wound is also present.

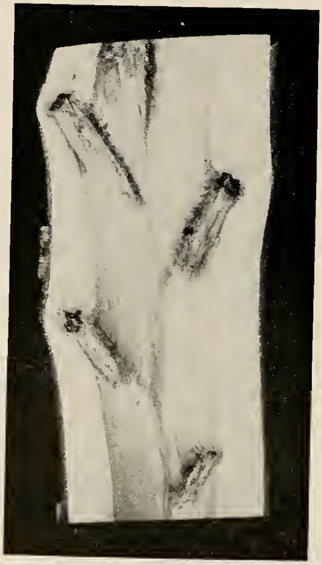
This new barrier wall usually functions effectively, and the invading microorganisms are confined to the older tissues formed when the tree was wounded. They seldom expand into the new tissues formed after wounding.

Now the invading microorganisms in an old wound are trapped, in a sense, by chemical barriers surrounding them in the older tissues, and by chemical and structural barriers between them and the tissues newly formed by the cambium. Apparently the barriers within the older tissues are not as strong (physically or chemically) as those in the younger tissues: the strongest are those formed by the cambium the growing season after wounding. Also, the compartments of wood tissue formed between the rays and growth rings are bounded on four sides, but not on the two ends. Microorganisms from past wounds then move fastest along this vertical path, and generally do not move horizontally outward into newly formed wood cells.

As the organisms make headway inward toward the older and less vigorous tissue, new chemical barriers constantly form in front of them. The tree also forms plugs in the vessels that impair vertical movement. Because of all these barriers, definite patterns of invasion occur, and understanding of these barriers within the tree leads to an understanding of the patterns of defects associated with certain types of wounds. Internal defects can be determined by an experienced forester from external indicators such as bulges on a tree's surface. Yet when wood is discolored as a result of processes initiated by wounds, it is often confused with wood colored as a result of aging.

Some tree species—walnut, oak, and white pine, for example—have a dark central core of true heartwood—wood altered as a result of normal aging and death. The presence of dead wood within the center of such trees is a normal phenomenon and in no way reduces a tree's structural strength. As heartwood cells die, the materials in them are altered chemically and serve as natural preservatives for the wood, causing the heartwood in many species to turn dark in color.

In beech, birch, and maple, and among other hardwood and some coniferous species, dark, central heartwood does not occur. The dark tissues in these trees form only as a result of processes initiated by injuries. The chemical products formed when a tree is first wounded are often dark in color—due to their combination with oxygen—and they give the wood a heartwood-like appearance. But there are differences between wood discolored by wounds and heartwood. Heartwood continues to increase in diameter as the tree expands and new xylem layers are added, while the columns of wound-discolored wood remain the same diameter because of the barriers formed by the cambium the year after wounding. Also, discolored wood differs chemically.


Microorganisms invaded this yellow birch through the open stubs of four dead branches. Branch stubs enveloped by new wood will form knots.

One of the most common ways in which a tree is wounded is from the falling of dead branches. When a branch falls, the cellular passageways leading from the branch into the center of the trunk provide a means for microorganisms to enter into the center of the tree. These central tissues then become discolored because of the tree's response to wounding and the tissues may continue to be invaded by microorganisms that intensify the discoloration as long as the branch-stub wound remains open.

Since wood is added yearly to a tree in the form of concentric rings, and since wounds are quickly surrounded by thick-celled barrier walls, invading microorganisms from new wounds do not readily spread outward into newly formed wood. They may move inward, toward the tree's center, until they come into contact with a barrier wall formed by a previous wound. This system always protects the younger, most orous tissues as the tree continue grow. Many times the wounds severe enough to be infected invaded, but an entire ring of w may not be completely invaded. stead, isolated streaks or islands defect form.

In the discolored columns of wo the bacteria and non-decay fu digest the food materials in the tered tissues. These pioneer mic organisms do little damage to structural portion of the tree, as they grow through the wood, t leave their waste products ab them, and many die, leaving th remains and adding vitamins to wood. The tissues first altered a result of the host tree's response injury are now altered further growth of the invading microorg isms. In turn, these dead, alte tissues become potential food still other microorganisms—the cay fungi.

Unlike the earlier types of ganisms that enter the tree, dec causing fungi can digest cell wal thereby weakening the wood. At t stage, bacteria and non-decay and cay fungi compete only among the selves and not with the tree, becau all of the tissues within the invad region are dead. Fungi and bacter continue to feed upon the tree's de tissues until decay is complete a only a hollow remains within t tree (although the tissues th formed after the tree was wound remain healthy). In beech, birc and maple it may take 40 to 50 yea before tissues are completely decay behind a wound, deep inside a tre After this occurs, fruit bodies of t fungi often form on the outside trees, drawing their nourishme from their tube systems of myceli which extend into the decayed po tion of the trunk, until the tr stands, hollow and dead.

The cause of death is not oft attributed to the many wounds i flicted over the years, or to the man stress factors that lowered the forc of defense and gave advantage to t invading microorganisms, for it difficult to properly assess all of the factors. Too often, the conspicuo agent that serves the *coup de grâce* marked as the sole cause of death for example, fungi that produce co cuous fruit bodies. But no one has r seen the bacteria and fungi owing through a living tree, and ce this process remains largely lden to view, its significance is nerally underrated.

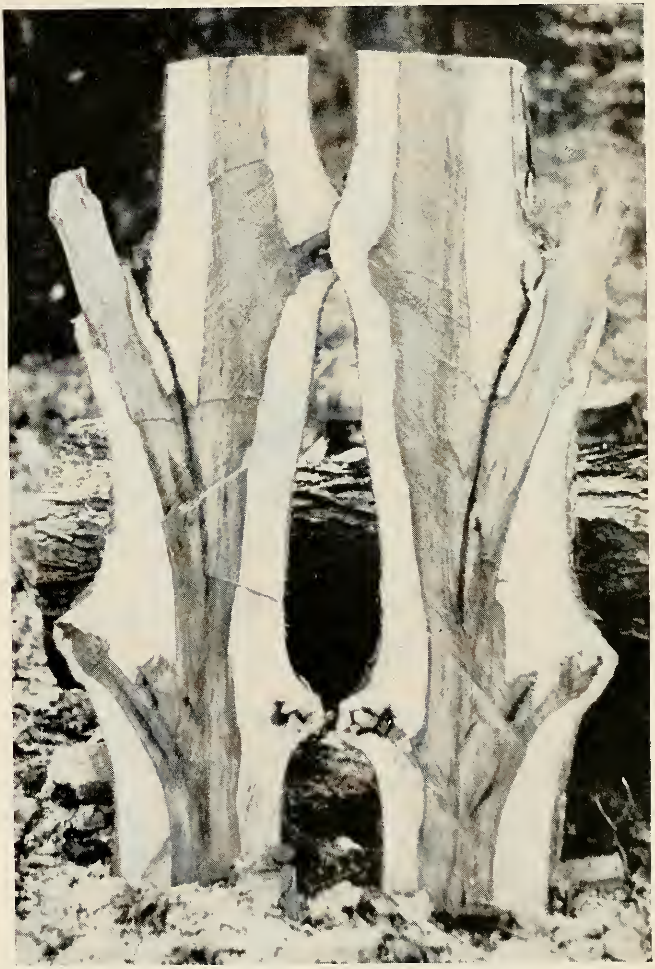
Following the death of a tree, a ferent group of fungi and bacteria gin to compete for the remains, for e food supply of the original fungi d bacteria vanishes as the living terial from the tree is decomsed. To the new organisms the ad tree is primarily a source of llulose, and their enzyme systems n break this down to sugar. No nger are there barrier zones to ntend with.

The dead tree still continues to rve several natural functions. Incts come by the thousands to feed the wood and to prepare a place r their young, making galleries in e wood. On their bodies many incts bring spores of fungi to the tree d these begin to grow in the galries. These fungi are well adapted the environment of the galleries. s the young insects grow, they have ready source of both wood and ngi as food. All of these organisms duce the volume of wood in the ee, and many of the fungi form coled fruiting bodies on the outside the tree.

Birds in search of food come to ck out the insects. The bark is torn d more wood is exposed, providing w locations for additional microganisms to become established. me birds may even peck out nest tes in the slightly decayed portions the wood. Other animals may use, shelters, the portions of the tree llowed by decay while the tree was ill alive.

Insects and small animals also gin to use the roots for food and elter. Slowly the once tight grip at the roots had on the soil is loosed. At the same time other porons of the tree become increasingly ittle; wind, snow, and ice begin break some branches. Eventually e tree falls; the wood is in contact ith the soil, again providing a new ological situation.

Some species of trees, such as the merican chestnut, resist complete ecomposition for 50 or more years fter falling. Other species, such as eech, birch, and maple, usually decompose in less time. As soil organisms begin to work upon the fallen tree, dead leaves and other dead organic materials on the forest floor serve as an insulating blanket for the under portion of the tree, serving to protect such microorganisms as slime molds, bacteria, and actinomycetes from the heat in summer and the cold in winter. Different species of microorganisms remain active all year and the once-living tree is finally completely decomposed, the corky bark being the last portion of the tree to yield. The portions of wood not digested by the many surface microorganisms are incorporated into the organic layer of forest soil, finally losing all identity within this universal medium.



The patterns of discoloration in this sugar maple show the typical path of invasion by microorganisms entering through branch stubs. Fungi and bacteria moved vertically through the wood vessels but horizontal movement was prevented by the tree's formation of chemical and structural barriers.

Victorian Fashions at the Edge of the Kalahari

by Frank L. and Dora Lambrecht

Water for tea was boiling in the black cast-iron, three-legged pot when Makopo returned from an afternoon of shopping in Maun, capital of N'gamiland, Botswana's northwestern district. Tucking away a shilling in her head scarf, she sat down slowly and carefully so that her long skirt would fall in accordance with Herero etiquette, hiding legs and feet. All the other women of the tea party had already seated themselves around the campfire.

The sand and the gray walls of the huts threw off the heat of the late afternoon sun in oppressive waves. The tea was now being served in white enamel cups. Milk was passed around in a small calabash, and sugar in an empty corned beef tin, while the guests used a single spoon to stir their tea.

Makopo told about her shopping trip and the new dress material that had just arrived at the Greek's shop. Everyone listened more intently, however, to the letter Esther read from her husband, giving the latest news from the cattle post, some 50 miles deeper into the Kalahari.

Three or four dogs, attracted as usual to people sitting around the campfire, were chased away with angry gestures. A few men also drifted toward the circle of chattering women. They were left standing, however, while the women continued talking in a detached way, making it obvious that this was their hour and their party.

When the sun set, Makopo rose slowly, drew her shawl around her shoulders, said goodbye to no one in particular, and with the swaying walk characteristic of Herero women, went to her hut at the far end of the village square. One by one, others rose, chatted some more, and then dispersed to their respective quarters. The tea party was over.

We observed this gathering during our first visit to the large village of Maun. Unknowingly, we had entered the Herero section, where we saw tall, brightly dressed women walking with stately bearing among the huts. Initially, we met with suspicious and even hostile looks, but later we were accepted without mistrust.

The Herero are relative newcomers to Botswana (formerly Bechuanaland). As a result of their disastrous wars with the German colonial forces in South-West Africa at the beginning of this century, large numbers of Herero were killed. Some of the survivors crossed into northern Bechuanaland where they were accepted by the ruling Tawana.

Cattle are the Herero's life and fortune, love and frustration. Although they lost their cattle when they fled South-West Africa, the Herero in N'gamiland have managed to build up large herds again by trade, good husbandry, cunning, and some say, theft. With foresight, they kept their livestock in grazing areas outside the reach of the advancing tsetse, which inflicted heavy losses on the herds of the less careful Tawana.

Herero men are known for their proud demeanor, but it is the women who are most remarkable in appearance. Their multicolored Victorian-style dresses stand out in dazzling contrast to the dun surroundings, especially at the height of the dry season when the trees and bushes have lost their color and the grass has turned to straw.

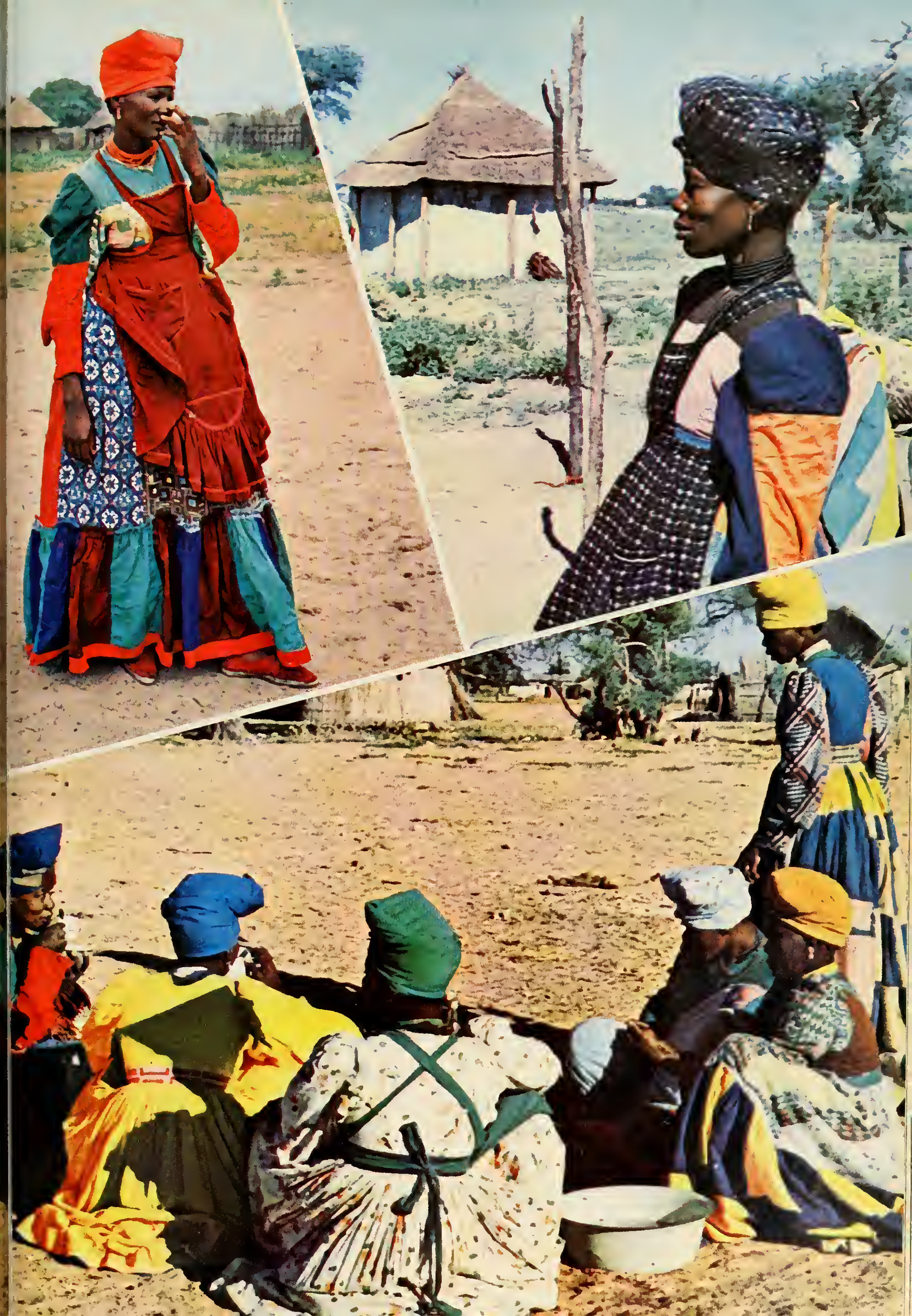
Basically, the style of the dress is similar to the one introduced by the uncompromising German women pioneers in the first half of the last century. It is hard to understand why Herero women have retained, and adopted as their traditional costume, a type of dress poorly designed for the tropics; furthermore, one that was copied from their German foes. However, the *ohorokueva*, as the dress is called, has acquired special refinements and has become a bright, individualistic creation. The patchwork of diverse and colorful materials often used to "compose" the dress is a far cry from the austere fabrics of the pious pioneer women. Because of the unlimited possibilities of mixing colors and designs—some dresses are made from small pieces of different fabrics—no two Herero dresses are alike.

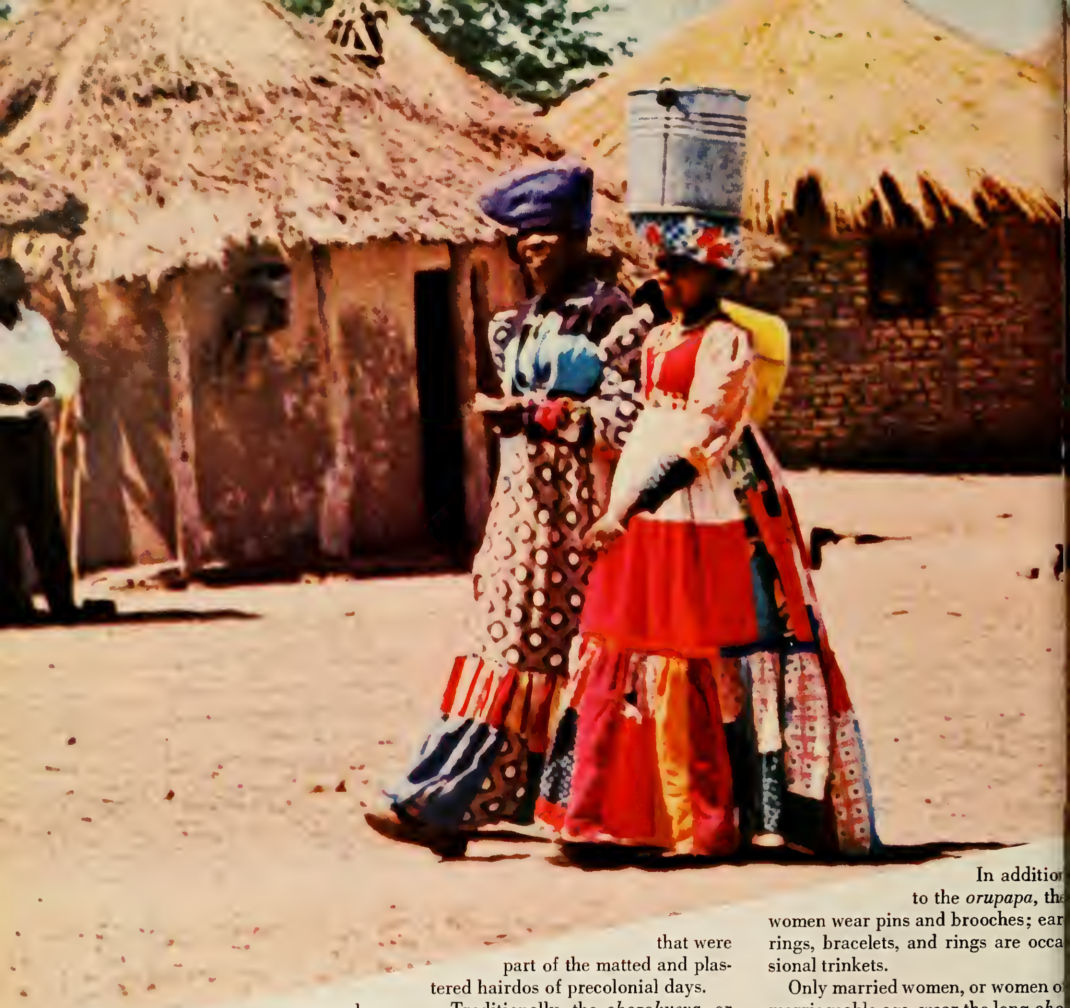
A complete outfit consists of either a one-piece dress or bodice with skirt, a head scarf (a sort of turban), a shawl, an apron, a belt, three or four layers of petticoats, necklaces, and some other jewelry.

Sometimes ornamental ribbons, reminiscent of the German corselet, are sewn on the bodice, or narrow ruffles are stitched on the blouse in imitation of a Victorian yoke. The sleeves are long, with lined cuffs or buttoned wristbands. The skirt is voluminous. Gathered at the waist but flaring out at the bottom, it requires at least twelve to fourteen yards of material. The underside of the skirt is finished with a wide, gathered valance, or flounce, and sometimes the skirt's width is increased by gussets.

From two to five white or solid-colored cotton petticoats are worn underneath the skirt, adding to the flared effect at the bottom, and accentuating the Herero woman's swaying, undulating walk.

The skirt is topped by an apron, of which there are two kinds: a long one for work and a short one, far more ornamental, for dress. The waistline is accentuated by a belt, usually made of thick leather or plastic covered with dress material, and preferably adorned with a medallion-shaped clasp of either copper or white metal. The shawl forms an integral part of the outfit. It is not





worn, however, when the Herero woman is at her chores. Often handmade, but also store bought, the square shawl comes in all colors and fabrics. It is usually made of light, even sheer, material; but during the winter, when its function is more than decorative, a heavy blanket material is used.

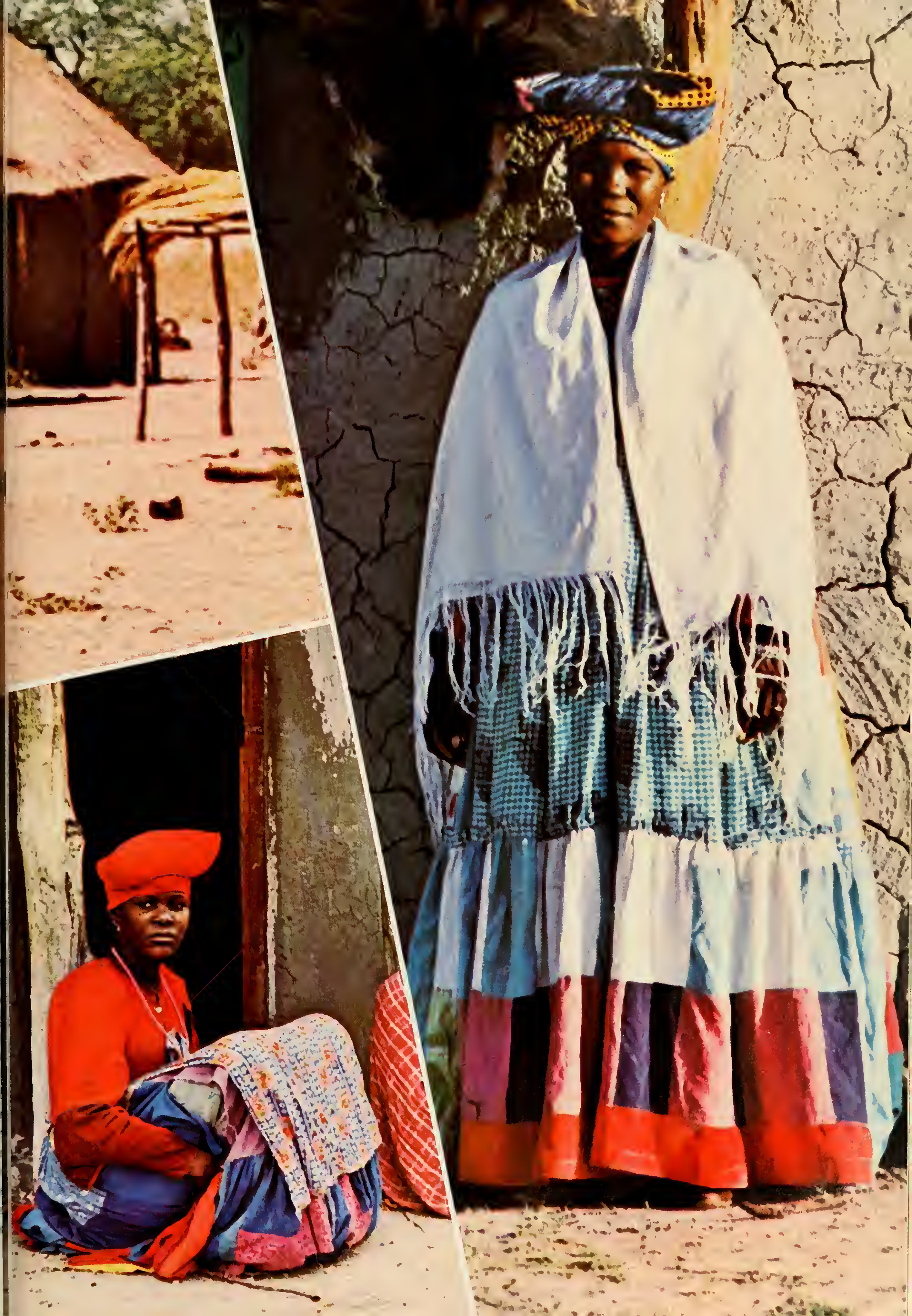
With the exception of her husband, no Herero woman is ever seen by a man without her head scarf. She wears it even during childbirth. This important article of clothing is somewhat square and flat on top, padded from the inside to give it "body," and knotted into a kind of platform from which two frontal horns protrude. The latter are somewhat reminiscent of the "horns" of cow hair that were part of the matted and plastered hairdos of precolonial days.

Traditionally, the *ohorokueva*, or dress, is never worn without rows and twists of vividly colored trade beads cascading down the bodice. The favorite beads are diamond- or cube-shaped, cut from a superb-smelling soft, dark wood. Called *orupapa*, these fragrant beads are often strung together with small glass trade beads. When they are not worn, the *orupapa* necklaces are kept in a small box with some sawdust mixed with a kind of iron-oxide. This keeps the beads shiny and retains their color. Ground *orupapa* is often added to the sawdust mixture to insure the continuing fragrance of the beads. The perfume of the *orupapa*, the Herero say, enhances a woman's attractiveness; "no woman should smell like a goat."

In additio to the *orupapa*, th women wear pins and brooches; earrings, bracelets, and rings are occasional trinkets.

Only married women, or women o marriageable age, wear the long *ohorokueva*. Teen-age Herero girls wea a short version, with short, puffe sleeves, but they do not wear th shawl, apron, or head scarf.

Once she reaches marriageabl age, she will be proud to wear th complete outfit, although at first sh may have difficulty accomplishin the complicated knotting of her hea scarf. Daily practice will be require to wind it to the proper height an prescribed forward and downwar tilt. a sign of an elegant woman. Sh will also take excellent care of he dresses, patching and washing the frequently. But her efforts will be well rewarded, for she will hav achieved the distinctive dress that th tall, graceful Herero women conside a mark of maturity and dignity.



Collecting in the Galápagos "where wood borers feed on fifty-foot 'daisies' and beetles have lost their wings"

Oceanic Filter, Game of Chance

by David Cavagnaro

The equatorial latitudes harbor nany secrets, hidden mostly in the ain forests of steaming river basins ind mountain slopes. But strangest of all lands touched by the Equator nust certainly be the Galápagos Islands, a heap of clinkers 600 miles vest of the coast of Ecuador. "This is iot a normal country," wrote naturalist William Beebe, "it is something more and less than other tropcal lands." On both counts, Beebe vas absolutely right.

On these volcanic isles, famed for heir importance to Darwin in the ormulation of his concepts of evolution, live 40-foot cactus trees, gargantuan tortoises, and little, puffy penguins. There are barren rubble ields of lava, sharper than beds of nails, and dense cloud forests, silent but for the tick of mountain rails. It s a mysterious land, alive with biological treasures and filled with the beauty of wilderness.

In 1964 I joined the Galápagos nternational Scientific Project as an entomologist to survey the insects of he archipelago for the California Academy of Sciences. For six weeks, ive other bug hunters and I combed several islands looking for insects. Many places we visited had never been explored before. After the others left, I stayed behind as a ranch hand of sorts on a farm in the highands of Isla Santa Cruz, and during he next five months, I explored two additional islands and made thorough collections in the remote reaches of Santa Cruz itself.

Previous to 1964 insect collecting n the Galápagos had been infrequent ndeed. Darwin himself made the irst important collection during the voyage of the *Beagle*, even though he visited the islands during the driest time of the year. In 1906 the California Academy of Sciences launched a monumental expedition by sailing vessel, and Francis X. Williams—who to this day has many a wild tale to tell of these rugged islands—gathered one of the most important collections of insects ever made there.

Collecting techniques and methods of transportation have greatly improved since 1906, however, and we were able to probe many regions and numerous habitats never before reached. With flight traps, black lights, Berlese funnels, and other special devices we gathered scores of species new to science. We discovered numerous insect families and two orders previously unrecorded in the islands.

Since 1964 the collections have been studied by specialists both here and abroad. Now we can begin to understand more clearly the pattern of insect evolution in the Galápagos.

The archipelago lies in a peculiar climatic region known as the Pacific dry zone. Weather there is a far cry from the torrential rains usually associated with equatorial regions. A long dry season prevails during most of the year, broken only by mists and drizzle in the highlands. In January and February, heavy rains normally fall over most of the archipelago, and the desert lowlands become lush and alive with insect life.

It was during this time, early in January, that we arrived in the islands. At Academy Bay on Isla Santa Cruz we were beseiged by swarms of insects. The lights of Darwin Research Station were lost in clouds of moths and winged ants. Hordes of colorful, giant *Schistocerca* locusts ravaged the ephemeral greenery, and caterpillars made lace out of the leaves of bushes and trees. Soon we began to see that indeed this was not a normal country. for although insects were everywhere in abundance, countless groups familiar to us on the continents were nowhere to be found.

Search as we might, we could find only seven kinds of butterflies, and a lone species of carpenter bee had all the flowers of the islands to itself; not another type of bee could be found. On the older islands, many ponds dot the landscape during the rainy season, but they are lonely ponds, frequented by a few kinds of water beetle, the nymphs of one species of damselfly and several kinds of dragonflies. Where were the mayflies, caddis flies, and stoneflies that grace the mountain ponds and streams of

North and South America? Where were the walking sticks that occur everywhere on the tropical American mainland?

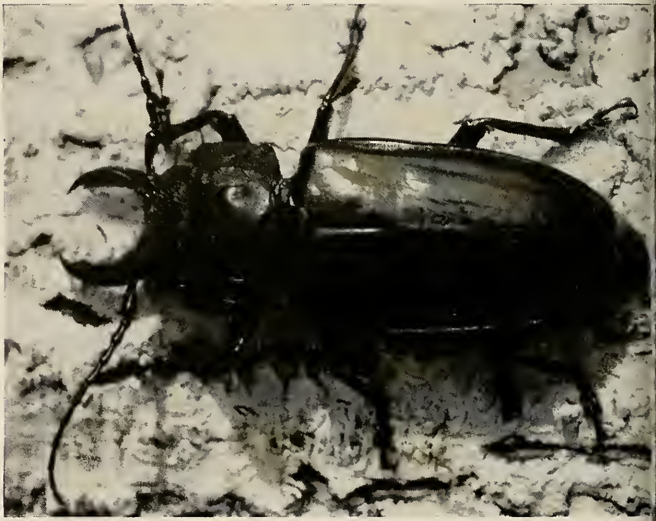
We soon learned that out of thirty orders of insects, twelve are totally missing from the Galápagos, and only 52 per cent of the insect families found on the nearby continent have colonized the islands. A deficit of diversity prevails. The reason is a simple one.

It is a matter of oceanic filters and the game of chance. The Galápagos are oceanic volcanic islands, which have, like the Hawaiian group, risen from the floor of the Pacific. They were never connected to the continent, and every basic type of plant and animal found there had to cross a large stretch of open sea. Although the distance may have varied during the past million years, any bit of ocean is a barrier, and 600 miles is a long way to fly if you're an insect.

Many a country boy must watch in wonder as flocks of swallows hawk about high in the air, darting about so far up that they seem mere dots against the clouds. The swallows are catching insects, invisible to us from the ground, yet numerous enough to attract these hunters of swift wing. High above the land and carried out to sea on invisible streams of air are countless tiny insects, a layer of aerial plankton drifting along much like the floating plankton of the sea. Over the millions of years this process has been going on, some of these insects must have fallen by chance on oceanic islands. Most were dead on arrival, but once in a while a living insect full of eggs settled on an island.

Inspired by the problem of insect dispersal to the Hawaiian Islands, members of the Bishop Museum staff in Honolulu have conducted aerial-trapping surveys in many parts of the Pacific. By attaching special nets to airplanes and ships, the museum collectors have gathered sixty insect families in twelve orders at various altitudes over the Pacific. Six families of insects have been trapped 500 to 600 miles from the nearest land, minimum range of an air journey from the coast of Ecuador to the Galápagos. All of these orders and most of the families are represented in the Galápagos. In similar surveys over Louisiana and other parts of the United States, spiders and insects have been trapped by plane, some as high as 14,000 feet.

Insects must have spread similarly among the many islands in the Galápagos. Standing on the highest peak of Isla Santa Cruz one afternoon, I watched in amazement as clouds of insects swarmed above me, borne aloft high over the island's summit. Now and then a Galápagos martin darted past in pursuit of food. Many miles to the north, in the direction of the wind, I could see Isla Santiago. I could not help thinking that once in a great while some of those insect voyagers would be carried across the sea and would reach Santiago.



Above, the largest Galápa
beetle, Stenodontes galapagoen
Giant centipedes, right,
all close to twelve inches lo

Nothing is known directly about aerial movements of insects to and among the islands of the Galápagos, but it is easy to speculate about what might have happened during the millennia since the islands first made their appearance above the sea. The lands from which Galápagos insects have come range from Mexico, Central America, and the Caribbean, southward through Ecuador and Peru. These are regions of lofty mountains and scattered peaks where the air is turbulent, where strong updrafts generate thunderstorms and immense cumulonimbus clouds. Throughout these mountainous lands insects are borne aloft on strong air currents, just as I saw them over the breezy summit of Santa Cruz. Protected from dryness by warm, moisture-laden cushions of air, some of these delicate animals might be carried far out to sea in swiftly moving air streams. Most would die, yet a few might survive long enough to fall upon the Galápagos.

A few strong fliers have actually flown to the islands. The queen butterfly, like its closest relative the monarch, is an excellent flier and tends to wander. These colorful butterflies now breed among vine milkweeds on the larger islands and are wayward visitors on smaller islets.

The painted lady is generally believed to be the most widely distributed butterfly in the world, and two of its closest cousins are also known for their wandering habits. The west coast lady, *Vanessa carye,* and the painted beauty, *Vanessa virginiensis,* have both managed to reach the lápagos. A sulfur, *Phoebis sennae,* d the gulf fritillary, *Agraulis van-ae,* are also excellent distance fliers th wide distributions. These four rial vagabonds could easily have urneyed to the archipelago under eir own power.

A dozen species of sphinx moths, l widespread forms, are now found the islands. These sturdy insects e probably the strongest fliers nong moths, and it is little wonder many kinds have successfully ade the trip across the sea. Dragon-es are also known for endurance ing, and several reside in the alápagos.

One kind of insect actually walked ere, the little marine water strider *alobates,* whose name means reader of the sea." While a fair mber of mammals, birds, and rep-les have in the course of evolution turned to the sea, very few insects ve become adapted for life in any ay connected with ocean water. nd only *Halobates,* alone among arly a million kinds of insects, has ade the daring break with land to nture across the oceans of the orld, living and breeding on the en sea. Where these voyagers have countered islands and sheltered astlines, they have at times settled nd gradually become modified as ew species. The Galápagos striders, unique to the archipelago, have—like sailors and adventurers turned fishermen—given up their wandering habits and now live close to the sheltered shores. The islands are still visited by their traveling relatives, for two far-ranging species have been found in Galápagos waters.

Some insects came on rafts, perhaps lodged deep within a floating log; others hitchhiked among the feathers of a wayward bird. However the mode of travel, from the few who made the trip and survived to lay their eggs have evolved all the species we see today in the Galápagos.

We must realize that any of these transoceanic voyages are extremely rare occurrences. The chances for an insect to begin such a journey are small; even smaller are its chances of landing in the Galápagos. The key factor is time. Over the few million years the Hawaiian Islands have existed above the sea, only about 250 insect species reached the islands and became established there. From these original stocks all 3,722 known endemic species of Hawaiian insects have evolved.

Although Galápagos insects have not evolved new forms to the remarkable extent seen in Hawaii, most of the original colonists have become very different from their mainland relatives, and some have produced a variety of species on the various islands, diversifying after the fashion of the famous Darwin's finches and giant tortoises.

The butterflies and larger moths found in the islands are for the most part considerably smaller than their relatives on the mainlands. The small, dusky Galápagos version of the gulf fritillary has become different enough to be classed as a distinct subspecies, *galapagensis.* Island dwarfism occurs elsewhere on oceanic islands and the reason, perhaps related to scanty food supply, is not clearly understood.

Numerous insects in the Galápagos are flightless. Most of these are primitive insects, present-day survivors from a time when their own kinds dominated the entomological world. Very few families in these ancient orders have been able to span the ages, and because of a lesser degree of diversity than we find on the continent among the more advanced, highly evolved beetles, wasps, flies, butterflies, and moths, there have been fewer kinds available for dispersal to the Galápagos. Still a number of species have reached the islands as aeronauts or lucky hitchhikers.

Some flightless Galápagos insects, however, are clearly species that by all reasons of lineage should have wings. Loss of the ability to fly, and in many cases entire loss of wings, has a direct evolutionary relationship with the environment. The important factor here is wind. On the windswept barrens of Antarctica tiny, flightless flies feel their way carefully along protected corridors of rock-strewn fields. Deserts, often blasted by strong winds, give rise to wingless insects in much the same way.

Windy mountain peaks and the tops of oceanic islands are also well-known places for apterous species. Many peculiar wingless forms are found in the Hawaiian Islands, and the Galápagos Islands have their share as well.

Tiny web spinners, an obscure order known as *Embioptera,* were discovered for the first time in the islands by the author on the summit of remote Wenman Island, on the peak of Isla Pinzon, and again in thorn scrub on Isla Santa Cruz. The

family to which these insects belong produces winged males throughout its homeland on the west coast of South America, yet in the Galápagos the males have lost their wings entirely.

On Duncan I camped for a few nights just below the lower limit of the embiid colony. The wind was so strong all night that I had difficulty securing my rain shelter even with large rocks. I thought again of the insect swarms drifting up the slopes of Santa Cruz and away over the highest peak. Almost all would die, many before mating. It occurred to me then that if the male embiids had wings like all their continental relatives, they too would stand a high chance of being swept away from their small colonies on the island summits. Many of the males lost in this manner would not have mated and would not therefore have passed on to subsequent generations the genetic trait of having wings. As soon as winglessness appeared flightless males would rapidly have become more and more common, transmitting to their offspring the genes for aptery at a faster rate because of the increased odds of mating.

The *Calosoma* ground beetle, a very active flier, occurs throughout the desert lowlands of the archipelago. Wherever these beetles have ventured into the highlands, however, they have lost their flight and in some cases their entire flying wings. Each of the larger volcanoes, from about 3,000 to 5,000 feet in elevation, appears to have a unique species working its wingless way in search of a living among the ferns and grasses on the misty summits.

Some insects that undoubtedly journeyed to the Galápagos did not survive once they arrived. For many it was a problem of menu. In some cases the particular food plant of a dietetic specialist was missing from the flora. In the same way, parasitic species are almost entirely lacking because their particular hosts were nowhere to be found in the new land. Only a few parasites with flexible culinary tastes are found there now. Since native land mammals do not occur in the islands (with the exception of bats, whose parasites hav not been investigated), fleas an mammal lice are not native to th Galápagos.

Volcanic striations and
sun dapple west face of J
Island, above. At right, c
cacti on Santa Cruz Isl

Ticks do abound in certain places however. To our dismay we discovered great hordes on Isla Fernandina where we camped within an immens land iguana colony. Although th ticks usually feed on these huge four foot lizards, they attacked us wit great relish. Little wonder that afte thousands of years of iguana a la carte they were eager to sample a new bill of fare!

Although most insects and othe terrestrial arthropods are small an inconspicuous, a few large specie are hard to miss. In the highlands o a few larger islands, in forests of tal "tree sunflowers" of the genus *Scalesia,* lives the largest Galápago

etle, a long-horned wood-boring
etle whose three- to four-inch
ubs feed on fallen *Scalesia* logs. Al-
ost everywhere, large dragonflies
rt about in search of breakfast.

Most incredible of all are the giant
ntipedes, a full twelve inches in
gth, whose nocturnal searches for
od and shelter often ended inside
r sleeping bags. Anyone who has
mped in the Galápagos will testify
at foot-long centipedes make
ghty poor bedmates. Collecting
ese creatures presented still an-
her problem. Bottling them with
pair of tweezers was like bagging
mad tiger with a butterfly net, and
e result was always a series of deep
ratches much like the product of a
ht with an alley cat. Expedition
tanists came to the rescue, how-
er, with a pair of hot-potato tongs
ed to gather spiny cactus pads.

Insect collecting in the Galápagos
s certainly not always a normal af-
r. So tame is the wildlife there,
at insect gathering often became
ite competitive. On numerous occasions, having just turned over a stone or broken open a rotten log exposing hordes of termites, grubs, and other succulent specimens, flocks of mockingbirds and a dozen or more lava lizards would emerge from surrounding thickets and join the foray with great relish, totally unmindful of my frantic tweezer picking. It is most disconcerting to be outmaneuvered by a lizard and even more frustrating to watch helplessly as new species go swiftly down the hatch.

We had a hazard of another sort on tiny Culpepper Island in the far north of the archipelago. Because of its sheer cliffs Culpepper had not been ascended prior to 1964. Early in the expedition a group of us were lowered onto the summit plateau by helicopter, and there we found ourselves in the midst of an immense seabird nesting ground. Most numerous were the sooty terns, which use Culpepper as their only Galápagos nesting site.

Practically every square foot of the island was occupied by terns nesting on the ground beneath low *Croton* shrubs. Eggs were so numerous it was not possible to avoid damaging some. As we crawled about the island overturning rocks in search of insects, we couldn't suppress the thought that we were in one of the world's only places where it seemed impossible to leave a tern unstoned.

The study of Galápagos insect life has really only begun, and many evolutionary and biological subtleties remain undiscovered in these far-off volcanic islands, where wood borers feed on fifty-foot "daisies" and beetles have lost their wings. It is most fortunate that the archipelago is now preserved as a national park of Ecuador. The Charles Darwin Foundation operates a research station at Academy Bay, an excellent staging ground for island study and exploration. The Galápagos National Park is a priceless preserve; every treasure within its boundaries is unique and irreplaceable. The thrill of wilderness is everywhere, and it is indeed "not a normal country."

SKY REPORTER

SPACE DETERGENT Molecules of ammonia—long the housewife's cleaning-day ally—have been discovered in interstellar space in the direction of the galactic center. With one atom of nitrogen and three of hydrogen, the molecules are the most complex ever found in space.

A group of Berkeley physicists, led by Nobel laureate Charles H. Townes, made the discovery with a 20-foot radio telescope at Hat Creek, California. Since they reported their finding in *Physical Review Letters*, they have found more ammonia molecules in adjacent regions. All are within dust clouds where hydroxyl radicals (molecules of one atom of hydrogen and one of oxygen) had already been found.

Because most scientists believe that stars and planets condense out of clouds of dust and gas, the existence of ammonia in such clouds is doubly significant. Ammonia is considered an important precursor to the organic molecules that set the stage for the evolution of life. The atmosphere of the primordial earth is believed to have contained ammonia. Lightning discharges provided the energy to form more complex compounds.

The Berkeley discovery will intensify the search for other gaseous compounds in the dust clouds at the center of our Galaxy. Water and methane are likely candidates, as are other combinations of oxygen, hydrogen, carbon, and nitrogen.

ULTRAVIOLET COMES OF AGE In the last 15 years, sounding rockets provided astronomers with all of three hours of ultraviolet observations. Perhaps 150 stars were examined. Now two tons of optics and electronics thrown into orbit last December 7 are providing twice that amount every day.

This country's most ambitious scientific satellite to date, the Orbiting Astronomical Observatory, is examining ultraviolet radiation—energetic light rays that are unable to penetrate the earth's atmosphere. The OAO data will achieve two purposes: it will extend our knowledge of known objects into important new areas, and it will give us our first good look at objects practically invisible from the earth's surface.

We now believe that a cool protostar emits most of its radiation at infrared wavelengths. But as it contracts further it rapidly becomes so hot that it radiates at a much higher intensity—at the ultraviolet wavelengths. Detailed examination of this radiation will fill a major gap in our understanding of stellar evolution. The OAO data will be translated into compositions, densities, temperatures, and pressures.

During its scheduled six-month tour of duty, the OAO is also scheduled to look at red giants and white dwarfs, bright nebulae, and even several planets. It may discover entirely new classes of objects, comparable to pulsars or quasars.

The OAO is the second flown by the U.S.; the first lost power after launch in April, 1966. A third, carrying a 38-inch telescope, is scheduled for launch late this year. The fourth and last, equipped with a 31-i telescope, is set to fly in late 1970.

Astronomers look on the space observatories v mixed feelings. The data they provide cannot be tained in any other way, but to launch a single O costs four times as much as it would to build a sec Palomar reflector.

GOOD YEAR FOR AMATEURS The ba yard astronomer is more than holding his own des the space program and a proliferation of new pro sional instruments. In fact the professional is still tu ing to the amateur for help every now and then.

The American Association of Variable Star servers, an amateur group, has closed the books o record year. During the year its members recorded magnitude of variable stars 140,812 times. One memb Mario Vattuone of Buenos Aires, made 10,103 obser tions. Fifty-one observers made more than 500 obser tions. Three managed more than 1,500 observati each of "inner sanctums"—stars fainter than 14th m nitude.

Professionals turn to the AAVSO when they beco interested in the past history of a particular star or request that a special observing program be undertak ("Sky Reporter," March, 1968). Interested amate should contact Mrs. Margaret W. Mayall, Director, AAVSO headquarters, 187 Concord Ave., Cambrid Mass. 02138.

CLOSING IN ON MARS While a new adm istration studies alternatives for a post-Apollo spa program, NASA is quietly going ahead with its barga basement plans to explore Mars. Despite budget unc tainties, the space agency has announced plans for landing mission there in 1973.

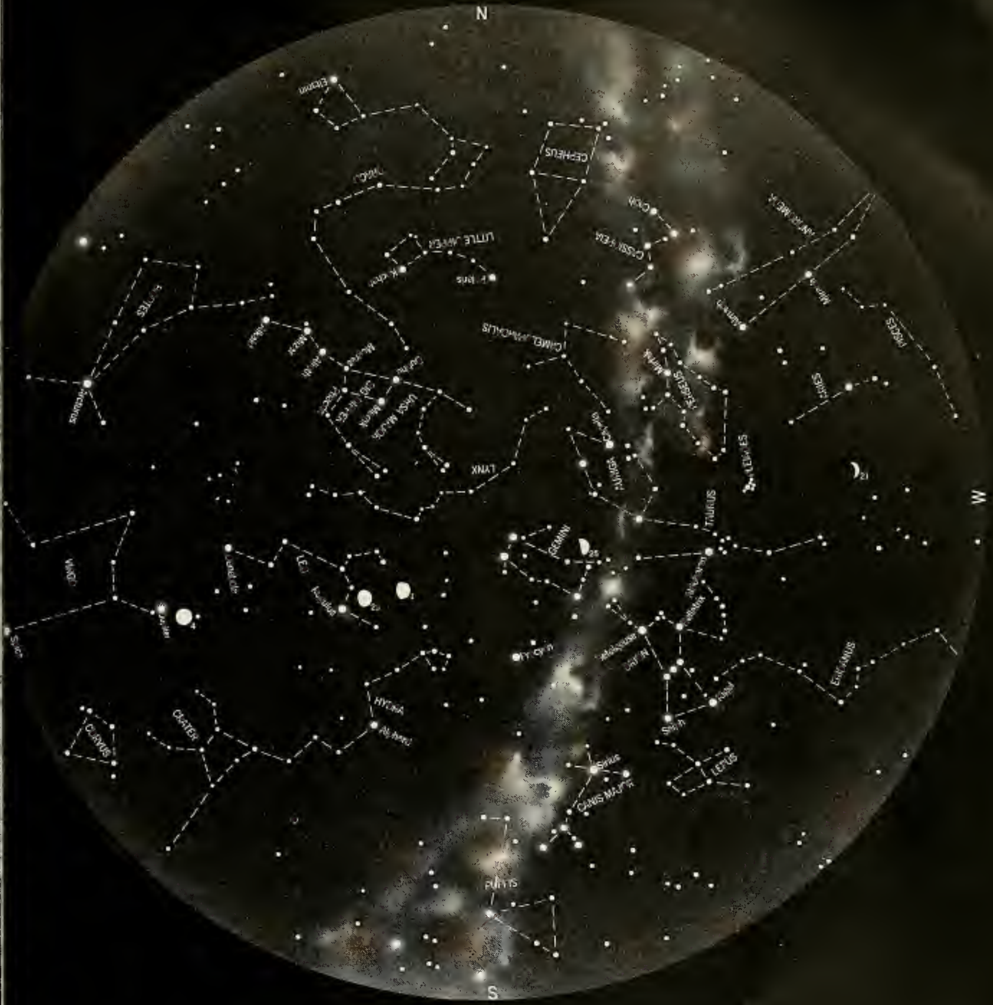
The trail will be blazed this year by two fly-by ca sules. At opposition in 1971, orbiters will take our fi long, close look at the red planet. Then in 1973 t spacecraft will go into orbit around Mars and dr soft-landing capsules to the surface. The landers w be similar to the Surveyors landed on the moon.

Scientific instruments for the landers have not be selected, but special emphasis will be given the sear for signs of life. The details are to be decided when t results from this year's flights are in.

NEWSWORTHY PULSARS Rapidly puls ing radio sources in the sky are no longer news, but the end of the year two pulsars did receive deserv attention. One was the first reported by the Sovi Union. A team at Puschino discovered it in the sout east corner of Leo. Its designation is PP for "Puschi Pulsar."

The other news was made by a pulsar near the Cra Nebula. Arecibo reported it had a period of 3.75 se onds, nearly twice that of any other known pulsar.

JOHN P. WILEY, J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Arcturus
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LYNX
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Capella
PLEIADES
TAURUS
GEMINI
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LEO
Regulus
VIRGO
Spica
Procyon
ORION
Betelgeuse
Rigel
Saiph
ERIDANUS
HYDRA
Alphard
CRATER
CORVUS
Sirius
CANIS MAJOR
LEPUS
PUPPIS

CELESTIAL EVENTS

Full moon occurs on March 4, last-quarter on March 11, new moon on March 17, and first-quarter on March 25.

Venus continues to dominate the evening twilight sky during the first half of March, but it fades in brightness and moves close to the sun by the end of the month. Saturn, also an evening star but not so bright, is close to Venus in the southwest at dusk. Jupiter remains visible all night long through March, rising in the east at dusk, setting in the west by dawn. Mars rises about midnight and is high in the south by dawn.

March 3: Venus is at greatest brilliancy in the evening sky, magnitude –4.3.

March 4-5: Jupiter is to the left of the moon as both move through the sky on the evening of the 4th; to the right of the moon, and closer, on the 5th.

March 9-10: Mars is the reddish object north of the moon after midnight tonight. The star Antares, similar to Mars in brightness and color, is to the left of the moon.

March 17: Venus becomes stationary in right ascension and begins to move retrograde (westward). The planet is now approaching the sun rapidly and will disappear from the evening sky before the end of the month.

March 19: Venus and Saturn are to the left and higher than the crescent moon in the twilight sky this evening. This is one of the last opportunities to see the two planets as evening stars this spring.

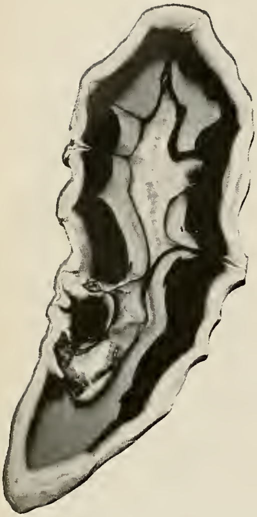
March 20: The sun arrives at the vernal equinox at 2:08 P.M., EST and spring commences in the Northern Hemisphere.

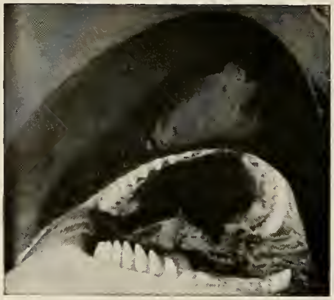
March 23: Jupiter is at opposition, directly opposite the sun in earth's sky.

Thomas D. Nicholson

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 9:20 P.M. on March 1; 8:25 P.M. on the 15th; 7:25 P.M. on the 31st; but it may be used for about an hour before and after those times.

A polished slice of agate from "Minerals and Man."

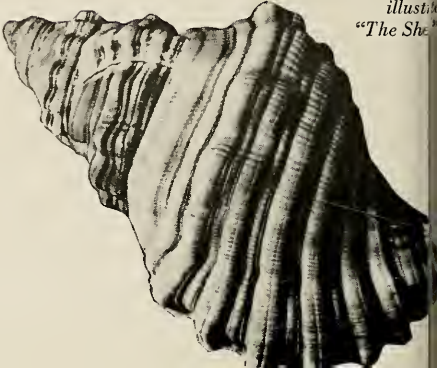




A quiet whaling harbor, the mouth of a killer whale, and an old print provide variety of illustration in "The Whale."

Oriental white egrets and bathing tiger are part of the animal life photographed in "Asia: A Natural History."

Mollusks of incred diversity and des illust "The Sh



Prescription or Winter Doldrums

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SHELL: FIVE HUNDRED MILLION RS OF INSPIRED DESIGN, by Hugh Marguerite Stix and R. Tucker Ab-., photographs by H. Landshoff. *ry N. Abrams, Inc., $25.00; 256 pp.*

producing *The Shell* Hugh and Marguerite Stix have successfully illed their desire to present the it world of beauty in shells. The in- lible variety of fossil and living lls that we see today has evolved r "five hundred million years." The spired designs" are the responses of soft-bodied, shell-producing ani- s to stresses in the environment. In book an appreciation of the natural uty of shells is combined with the erb photographic art of man to pro- e a symphony of shade, pattern, col- and form. Each plate is a work of the subjects to be admired for their ate beauty; the arrangement of the jects and the use of highlights, dows, and varied, effective back- unds to be appreciated as examples he skill of H. Landshoff, an imagina- and expert photographer. A book his size and elegance on mollusks not been published in more than hundred years. The figures of all cimens illustrated are at least natu- size and many are greatly enlarged; foldout plates measure 10½ by 20 hes and one 3-inch *Turritella* is en- ged to over 15 inches in length! The color plates are magnificent. The in luster of *Neotrigonia*, the gloss of the cowries, the pastel tints of the heart cockles, and the bolder colors of the scallops and cones are all faithfully reproduced. An arrangement in black and white of *Thatcheria* and *Ancistrosyrinx* is particularly pleasing. The enlargements of many of the shells not only emphasize characters of artistic quality but often show details of color pattern or sculpture useful in identifying a species but seldom illustrated in scientific papers.

The Shell recalls the magnificently engraved tomes produced by Regenfuss, Seba, Gualtieri, D'Argenville, Poli, Lister, and Perry: books that today can be seen only in libraries, museums, and a few private collections. The many references by the Stixes to the Japanese people and their love of shells, in addition to the magnificent, life-size color picture of the Emperor's Slit shell (*Pleurotomaria hirasei* Pilsbry), call to mind Y. Hirase's *Illustrations of a Thousand Shells*. This rare and beautifully colored, multivolume work was begun in 1914 in the old Japanese folding-book style not only to illustrate Japanese shells but also with the express purpose of preserving an example of the woodcutting art, which had reached such a high state of development in that country. A note on the back of the title page of *The Shell* tells us that it was printed and bound in Japan. So though no actual examples of Japanese art are illustrated or mentioned in the introduction, the entire book is a tribute to the state of the printing art in Japan today. The cover of the book is done in silk as was the cover of Hirase's work.

In the brief introductory text the authors discuss shells in relation to man from the economic, religious, and artistic points of view; the place of shells in the Middle Ages, during the Renaissance, and in the Baroque, Rococo, and Victorian eras. Of particular interest is the discussion of shells in pre-Columbian America, a phase of the history not usually covered in general books.

The 188 plates are accompanied by brief, authoritative, carefully written captions by R. Tucker Abbott, Curator of Mollusks in the Academy of Natural Sciences, Philadelphia, and author of many books on mollusks. These give the scientific as well as the common names of each species, the size, usually the range and habitat, and often interesting notes on color pattern, the rarity of the shell, its ecology, or the uses to which it has been put by man. Thus we learn that the Queen Helmet (*Cassis madagascariensis* Lamarke) is edible and that its shell is used for cameos; that *Xancus angulatus* Lightfoot was used as a lamp by the West Indian natives; that the Australian Trumpet shell is the world's largest univalve, sometimes attaining a length of over two feet; and that the Florida Horse Conch is the largest shell native to American waters. The bibliography on marine mollusks, also by Dr. Abbott, lists some of the most interesting of the more than 4,000 books on the subject. They are grouped according to areas of the world or under such headings as "Textbooks," "Art and Literature," "Children's Books," or "Gourmet's Conchology."

Although not intended to be scientific, the book is both scientifically accurate and artistic. It will be appreciated, therefore, by professionals who enjoy beauty as well as by enthusiastic amateurs who enjoy displaying, photographing, and discussing the shells they have collected on some remote island.

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RUTH D. TURNER
Museum of Comparative Zoology, Harvard

THE WHALE, by Dr. Leonard Harrison Matthews and others. *Simon and Schuster, $20.00; 287 pp., illus.*

This is one of those handsomely illustrated productions that are common these days, especially for gift giving, but this is not said to its detraction. Handsome is as handsome does, and this volume is both informative and attractive. Many old illustrations, maps, and charts accompany contemporary photographs or graphic drawings—such as the one showing the internal arrangements of a factory ship—and they guide the reader through whaleland on an enjoyable trip. I was particularly impressed by a photograph of the fantastic amount of krill in the stomach of one Antarctic whale.

The Whale's main author and supervising editor is Dr. Leonard Harrison Matthews, former director of the Zoological Society of London. Other contributors, in writing and editing the text, include scientists and leaders in research on whales and whaling from countries in different parts of the world. The whale, after all, is a global subject. By the same token, its conservation depends on international co-operation.

In fact, the world's preoccupation with whaling seems more evident in this book than the life and biology of the animals themselves, although there are two very interesting chapters under those headings. An early glance at the pictures of whale hunting, from the Faroes to Japan, might persuade the prospective reader that the title should be *On Human Aggression*. And the writers admit that until fairly recently the natural history of the whale was a much neglected subject. The logs of whaling voyages were often semiliterate, laconic, and in no way reflected interest in the habits of their prey except insofar as these contributed to a productive hunt. So whaling lore, which had its apotheosis in one great novel, *Moby Dick*, centered for the most part on an adventurous trade, its perils and its rewards, rather than on a life search of the animals themselves.

These great marine mammals are still elusive, with their habits only partially explored, and if they continue to be pushed toward extinction, this will not be remedied very much. However, research into the behavior of the cetaceans has been extremely productive during the past twenty years or so, p ticularly with respect to the dolph and the porpoises. It might have b useful, incidently, to have included least an attempted explanation of difference between these two groups the sake of the lay reader. I am sure, too, that the illustrative mate on the different kinds of cetaceans not somewhat awkward in relations to the printed text about them, a pr lem of arrangement that tends to ru the reader. Two more minor commen *The Whale* lacks an index, which wo have been helpful; and, records se to indicate that the Basque whal visited the Banks of Newfoundland least a half century earlier than first date given here, namely 1549.

But, when all is said and done, t book offers the reader hours of enj ment and provides an excellent and thoritative introduction to an aspect natural history in the marine envir ment that needs as much attention the world can give it.

JOHN H
Cape Cod Museum of Natural Hist

ASIA: A NATURAL HISTORY, by Pier Pfeffer. *Random House, $20.00; 2 pp., illus.*

To a biologist, the continent of As is the unnatural concept of carto raphers. Included in the boundaries Asia are the world's highest peak a its lowest land surface; its most exte sive deserts, widest tundras, and lar est surviving forests; some of its lon est rivers, its rainiest spot, and i harshest climatic extremes. The great portion of this huge and diverse area land is directly contiguous with the a jacent European continent, with whic it shares many common elements flora and fauna and forms the Pala arctic region of biogeographers. On its southeastern segment is separate by natural boundaries of topograph and climate, constituting the distin life-zone known as the Oriental regio

Dr. Pierre Pfeffer—in the sixth Random House's series "The Cont nents We Live On"— has resolved th problem of providing a coherent a count of the natural history of Asia b recognizing fourteen regions of distin tive habitat, based on climate as muc as geography, and treating each in separate chapter. The first seven hab tats are Palaearctic, the next two ar transitional, and the last five are trul Oriental, including peninsular Indi Indochina, and the coastal habitat, an (treated separately), the hinterland o the Malaysian subregion (which ca less ambiguously be called by its al ternative name, Sundaland).

Within each chapter no set form i

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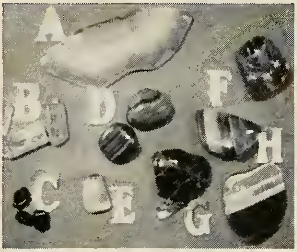

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followed, but successive sections highlight appropriate features of natural history. Section headings tend to be racy ("Living Toys and Miniature Elephants," meaning fennec and hyrax, respectively), but the text is straightforward and very comprehensive. South of the Himalayas, we enter the region where the author's heart clearly lies, and the writing is pleasantly lightened by anecdote and personal reminiscence. Although all measurements and temperatures are given in the awkward units demanded by the lay, English-speaking public, naturalists will be pleased to see that every living organism is identified by a Latin name as well as a vernacular equivalent.

Every page is illustrated by photographs in color or black and white; these are large, of high standard, and beautifully reproduced. All forms of life are depicted, but mammals and scenery predominate—in some cases combined to great effect. Only the black buck appears obviously to have been photographed in captivity (London Zoo?). Each chapter is also provided with a map; but unfortunately even major topographical features mentioned on the same page are not always shown.

The text has been translated from French to pleasantly literate English, and is almost entirely free from resultant confusions. Among those noted, however, were strange statements about day length and number of days; and instances when "humidity" should have been "precipitation," or simply, "rain."

A book of this size, scope, and price may well be sold for the sake of its beautiful illustrations. But the buyer should not then overlook the text, which more than succeeds in its author's modest aim of "conveying at least a superficial idea of this immense continent and its astonishing diversity."

LORD MEDWAY
University of Malaya

THE MINERAL KINGDOM, by Paul E. Desautels. *Grosset & Dunlap, $14.95; 252 pp., illus.* MINERALS AND MAN, by Cornelius S. Hurlbut, Jr., *Random House, $15.00; 304 pp., illus.*

Here are two mineralogy surveys long overdue. Colorful bird and wild flower books abound. But minerals, despite their frequent splendor and indispensability, have been stepchildren in the nature-book family. Indeed, it seems sad that many students can go through school without hearing that such a thing as a mineral exists.

Yet minerals are the building blocks of the earth. Essentially earthbound as we are, everything that we make or use or eat depends ultimately on the ea mineral crust.

It is true that to many, minerals less accessible than other natural jects. Any of us, like Walt Whit can gaze at stars when we wear verbal astronomy. We can all find b and flowers. But one needs a rock h mer or a nearby museum to ge minerals. Thus, competent, supe illustrated books, like each of t reviewed, are all the more welcome

Fortunately, each author retains passes to the reader his own love of subject, with an effect heightened a photographic selection that can be called breathtaking. For ther more to minerals than sheer uti Natural crystals display an or beauty, symmetry, and sometimes fection, unequaled elsewhere in ture. Too often even we professi mineralogists lose sight of the esth while enmeshed in our graphs tables—although it may have been beauty and lore of minerals that or nally attracted us. To me it was mag the way these books reawakened original awe and brought back museum hours of long ago.

Controlling the appearance and ting of each mineral are complex entific laws, treated in these books differing extents. Desautels goes m deeply into the ordered crysta graphic world that governs the di sity of mineral forms. Hurlbut tu more frequently to chemistry, to ba reasons for common mineral groupi in certain geologic environments, the geologic alchemy of mineral tra mutation.

Beyond science finally, to appeal the most unscientific humanist, b books unfold the vast human saga minerals. Man, since he first chip flint, has devoted much energy to fi ing, extracting, and using miner From primitive gravel screenings enormous open-pit scars; from g madness through the mystique gems; pottery to lasers; salt expe tions to Geiger counters—the grit a the sparkle of minerals are there in pages of history.

These books attempt much, and th succeed. Naturally they overlap c siderably, yet still complement o another due to differences in emphas Hurlbut stresses minerals themselv Desautels, human involvement w minerals; indeed, if the titles we switched, they would be more descri tive. In any case, neither fails to tra mit information, an appreciation for t subject, and perhaps the stirrings wonder. What more can any book d

BARBARA BLAU CHAMBERLA
Geologist and Auth

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ır eight years we have been organizing group
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a and the world. See summary of world
ram in opposite column. Below are details
oups now forming:

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nd the continent. We'll go as far south as
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ation highlights of the Andes and both coasts,
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iviera, Switzerland's birds and alpine flora,
med Neusiedlersee on the Hungary border,
nd the Rhine country; May 8. **EUROPE NORTH**
kes in northern Germany and covers Sweden
lly to and beyond the Arctic Circle; May 29.
ORWAY. our most popular of all, covers
ords, mountains and coastal islands in an
nerary that has become famous; June 22.
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ey "north with the spring" from the Mediter-
nean to North Cape and the Arctic.

ITERRANEAN begins at Lisbon, visits Spain's
med Coto Doñana, France's Camargue, Cor-
ca and northern Italy; May 8. **BALKANS** starts
Venice, visiting bird and botanical high-
ghts of Yugoslavia, Greece, Turkey, Romania
nd Hungary; May 29. **U.S.S.R.** starts from
rague June 22, covers natural history high-
ghts of Poland and Russia. **SIBERIA** is a 3-wk.
nk in an economical round-the-world route;
e Asian U.S.S.R. republics, Lake Baikal and
journey into Outer Mongolia are features;
ly 13. These 4 tours combine into an extra-
rdinary nature experience.

AIN, leaving May 29, is a popular broad
overage from southeast coast to north tip of
cotland. **ICELAND**, 2-week visit to this weird
ountry, offers a choice of departures (June 28
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vailable between the tours, and a visit to
reenland optional at the end.

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THE ORIGINS AND GROWTH OF ARCHAEOLOGY, by Glyn Daniel. *Thomas Y. Crowell Co., $8.95; 298 pp., illus.* THE FIRST CIVILIZATIONS, by Glyn Daniel. *Thomas Y. Crowell Co., $8.95; 208 pp., illus.*

From the pen of one of Britain's foremost archeological historians, who is a literary editor as well as a practicing field worker in archeology, have come two very different books. *The Origins and Growth of Archaeology* reflects the editor and historian—*The First Civilizations* reflects the practicing archeologist (prehistorian). Both are written in a rather popular style, but with a different purpose, and each will undoubtedly be read by a wide circle of laymen and professionals. Of the two, however, the latter recommends itself more strongly to me for a number of reasons, probably all the result of my admiration for Glyn Daniel's professional contributions to the field practice of archeology.

The Origins and Growth of Archaeology purposes to illustrate the way the discipline came into existence and how it developed. The method used is that of quoted extracts from the literature of the field, interspersed with the author's introductory, connective, and critical commentary designed to provide organizational structure and sequence. Editorially, the reader is led to Daniel's own definition of archeology ("to write history from the surviving material sources"—and to enjoy it), to his preference in excavation techniques (essentially Wheeler's "stratigraphic method"—to which I also subscribe, but which either baffles or infuriates other workers in the field), and to an insight and appreciation of a number of aspects of archeology in its development and present practice. Unfortunately, the author himself, only emerges to sway the reader's viewpoint at infrequent intervals. Most discernible are his rather specific discussion of the culture-study approach, his critique of terminology, and his enthusiasm for "absolute dates" on the basis of the radiocarbon method, all of which appear in the final chapter.

However, I felt that certain of the extracts were either too long, or irrelevant to the book's purpose. Also, a number of those used to define stages or trends were from sources relatively unknown, or too obscure in contribution, as archeology has developed to-

The annual index for
NATURAL HISTORY, VOLUME LXXVII
(January through December 1968)
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INDEX
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Overseas Nature Tours

— 1969 Program —

Here is a summary of our 1969 program. Space permits only brief mention of each tour, and one should, by all means, have the "Tour Catalog" with thumb-nail sketches of each trip. Early registration will save disappointment, and may be made tentatively. North America tours 2 wks., remainder of the world 3 weeks each, except as otherwise noted.

— NORTH AMERICA —

TEXAS BIRDS: Whooping cranes, Rio Grande reserves, Northeast Mexico. March 15.

TEXAS WILDFLOWERS: Separate wildflower group on above route. March 15.

ARIZONA: Popular bird tour of southeast Arizona under Dr. Robert Ohmart of University of Arizona. April 26.

CALIFORNIA: North-with-spring in parks, mtns. & off-coast islands. May 10 (3 wks.)

CASCADES: North through Oregon and Washington reserves and parks. May 31 (3 weeks.)

ALASKA: Three successive 2-wk. trips: (1) The inside passage and Yukon; (2) the central region with McKinley Park, Kenai, Kodiak and Katmai; and (3) outposts of the Aleutians, Pribilofs, Nome, St. Lawrence . . . Island, Kotzebue and Point Barrow. Series begins at Seattle June 21.

Note that the last 5 tours may be taken in continuous succession, following spring north in one great 12-week trek from the Mexico border to Point Barrow on the Arctic.

— MIDDLE AMERICA —

PANAMA: Bird concentrations of Canal Zone & Panama mountains. March 1-15.

Yucatan, Panama and Colombia are done twice a year in a continuous chain, affording a 7-week view of the bird and plant life of tropical America that is both memorable and economical. In 1969 this series starts Jan. 11 and July 19.

— SOUTH AMERICA —

COLOMBIA: World's top bird country. Two 1969 departures: March 15; Aug. 16.

ECUADOR-PERU: Heavy bird populations of jungles & high Andes, including Machu Picchu and upper Amazon. Sept. 6.

CHILE-ARGENTINA: Highlights of both coasts, plus Tierra del Fuego. Sept. 27.

BRAZIL: Iguasu Falls, the Rio coast, central jungles and the Amazon. Oct. 18.

GUIANAS-VENEZUELA: The 3 Guianas, Trinidad and highlights of Venezuela. Nov. 8.

The 5 South America tours, starting with Colombia on Aug. 16, readily combine into a remarkable grand tour of the continent.

— EUROPE —

By all means obtain the detailed announcement of our 11-tour 1969 Europe program, with its many possible combinations. See opposite column for additional information.

— AFRICA, ASIA, ETC. —

SOUTH AFRICA: This popular trip departs July 24, includes S.W. Africa and the Kalahari.

EAST AFRICA: Extremely heavy bird concentrations, many big mammals. August 14.

CENT. AFRICA-MADAGASCAR: New and promising, beginning at Victoria Falls Sept. 4.

JAPAN: Full-time birding from south tip of Kyushu to north end of Hokkaido. Optional extra week for tourist objectives. Aug. 2.

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day. A typographical differentia
between extract and comment
would have been worthwhile for eas
sorting out which was which in rea
the text. Finally, and perhaps n
importantly, I would have prefe
either the approach of the final cha
of the book—where the author's
contributions to the field and cur
viewpoints can be more clearly
cerned—or, a more complete, "Cer
like" anthology, wherein the auth
choice of extracts, reasons for
choice, and the precise contribut
made by the writer cited, could h
brought Daniel's acknowledged ed
rial skill and logical competence i
sharper focus.

When the 48 pages of plates, some
pages of in-text figures, and other m
cellaneous materials are subtrac
from the total pagination of *The F*
Civilizations, the reader is left w
only about 132 pages of text. Yet D
iel's contributions in this volume,
both historian and archeologist, ma
it a professional presentation of ma
significance (even though it is desig
less for the professional and more
the "popular" reader). In particul
the emergence of Daniel's current
thropological outlook in this volume
far broader (and more specific) th
in the past and will become a matter
professional concern in future disc
sions regarding the definition and
igins of "civilizations" ("culture"
The position put forward is present
so subtly, however, that the non-prof
sional will find no problem in eith
reading or enjoying the volume, even
there is no direct concern for the a
thropological theory and presuppo
tions of the conclusions offered by t
author.

An added commendation should
made in regard to the choice and qua
ity of the plates and the skill of H.
Shelley's cartography.

PHILIP C. HAMMO
Brandeis Universi

Briefly Noted:

SIERRA SOUTH, and SIERRA NORTH,
Karl Schwenke and Thomas Winnet
Wilderness Press, $2.95 each; 217 pp
illus.

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scribe 200 back-country trips into
marvelous country. They provide an a
curate description of the numero
trips that a mountain hiker-campe
may wish to take, complete with suc
important and detailed information a
the availability of firewood, the time r
quired to make each hike, the neces
sary landmarks, the esthetic potentia
of each trip, a description of flor
fauna, and geology, the appropriat
place to leave your car, the location o

npsites, and so on. It is difficult to ite an interesting guidebook, but awenke and Winnett have come as se as anyone to doing this. Their ysical descriptions of how to get m here to there are adorned with mor, historical sidelights, and with enlightened point of view in regard the natural environment. I would the books for that reason alone.

J. H.

THE WAKE OF TORREY CANYON, by hard Petrow. *David McKay Co., 95; 256 pp., illus.*

Richard Petrow, an American jourist, has produced a totally absorb; account of the *Torrey Canyon* dis-er. Reconstructing the captain's ddled, last-minute maneuvers to id running aground, Petrow details subsequent acts in the tragedy: the ntic efforts to refloat the ship, her al breaking up on the rocks, and the dly flow of oil toward the coast. st affecting, however, are the de-iptions of the victims of the dis-er: the oil-soaked birds, fish, mus-s, and other marine life that died by millions. The book ends with the quieting observation that another h tragedy is wholly likely.

E BRONX ZOO BOOK OF WILD IMALS, by William Bridges. *Golden ess, $5.95; 304 pp., illus.*

This volume outgrew its title, and actually a guide to more than two usand mammals, birds, reptiles, and phibians found all over the world. ile many can be seen in zoos, these mals in no way represent the col-tion of any one zoological park. The ural history of each animal is given, ng with common and scientific nes. Amply illustrated, the book uld serve as a handy reference.

C. B.

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Cedar Waxwing

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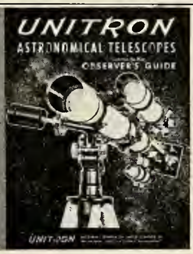

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A Naturalist at Large

Continued from page 24

pregnant woman will die within eight hours—or perhaps it is nine. So she almost killed herself running up the beach in the deep, hot sand to warn Junie to keep looking the other way. Don Chico Montalban came trotting up from his dugout on the river and asked Margie if I had killed the snake. She told him I had not, and he said that was bad. Not killing the snake was the worst possible omen, he said. So long as the snake was at large a cure was just about impossible. He nevertheless worked both himself and my wife up to the point of tears trying to make her get me to drink two fingers of kerosine.

At six-fifteen the boat came back from Parismina, having traveled fifty miles in three hours on a wild lagoon that never knew such speed. In it, with Marlin and Alvin, there came a pleasant young woman named Marta, who was the *curandera*, the curer, of Parismina. She was neither a doctor nor a *sukia*, a professional practitioner of bush medicine, only a woman with sense and a knack for doing the best that can be done in medical emergencies in isolated places. She was the wife of a solid Parismina citizen, and she spent much of her time fishing for tarpon and snook, treating illness only because, as I said, she had a good head and steady hand and sometimes knew better what to do than her fellow villagers did. When the boat docked she came straight up to where they showed her I was lying on the bed. When Alvin had introduced her she looked at me and without formalities started asking about my symptoms: swelling, breathing trouble, nausea—all the right things to ask about in a case of *Bothrops* bite. She looked closely at the wound, which by now was an unpleasant blue-green patch two inches across at the site of the punctures, but nothing more. She poked about briefly, thought for a moment, and then said, "It might be he didn't inject you." I eagerly told her that that was what I was beginning to think—that counting the boy who died of the antivenin, this was the fourth sure, solid *terciopelo* bite we had seen at the station, and none had produced snakebite symptoms. She said she had seen the same thing many times; but added that she had also seen a
man die two hours after being bitte
"Anyway, be careful for a few hou
more," she said. "Sometimes t
trouble comes later." She showed
the Butantan serum she had broug
and looked at our antivenin pack
we decided to give her some of ou
to add to her collection. "The inje
tions work," she said. "If you put
enough and put it in soon, th
serve; but also they are dangerous
And that, too, we agreed with.

After telling us a few snakebi
stories, she saw I was pretty slee
in spite of the coffee. She picked
the little bag with her medicine in
and started to go to her room. Wh
she reached the door she stopped a
looked back and said in Spanis
"Señor, it is important to kill a sna
that bites you," and I asked her wh
"Because sometimes there is
serum for a long time," she sai
"They say that then you should sp
open the head of the snake and ta
out the brain and mash it up on t
bite. Tie it there with a bandage.
helps, when there is no antiveni
Dicen [they say]," she said.

The airplane came at daylight.
came tearing in out of the mis
buzzed the house, banked, an
landed on the grass and sand of th
seaside strip. Margie and I got in i
and an hour later we were in Sa
Juan de Dios Hospital, and Dr. P
checo was saying, "I can tell yo
without any doubt that you were n
injected with poison." I asked hi
if he ever before heard of anybod
being struck hard and squarely b
a big *Bothrops* and coming awa
with no poison, and he said yes. W
thanked him and he congratulate
me, and we left and spent the rest o
the day lying around the hotel to ge
over the coffee, the tobacco juice, an
the scare. The next morning, early
we flew back to the station.

For some days Miss Junie wa
hampered in her work trying to kee
from seeing me. Nobody seemed t
know how long it took for that haz
ard to die down. It made it hard o
both of us having to slide aroun
the walls to keep her from seeing me
She also made my wife hide the pant
I was wearing at the time I was bitten. It was suicide to wear them
again, she said. Shefton said he was
glad I was alive, but he cautioned me
that there was no real cause for relief

il the nineteenth day, on which
en people are prone to drop dead.
'ore that, though, he said—after
ut a week—the discolored area
ere the snake had hit would loosen
right down to the bone, and fall
to the ground. But I was feeling
good by then that his forebodings
n't bother me very much; and
way, Bertie Downs, our only
ghbor for half a mile down the
oon said nothing at all would hap-
to me. His reasoning was like
: "The snee-ek that hit you hob
oll in the mid-del, a *conejo* or nex
ality of onny-mal. Before the *ter-*
pelo eat any smoll onny-mal she
ll to the sea and wash the mouth
lean, to put out the py-sen. So any
e the boll in the belly, the *tercio-*
o can not do no dom-age at all."
aring that, Shefton shook his head
l out of the corner of his mouth
mbled, so Bertie couldn't hear,
is ridiculous, Doctor. This only
ytown superstition."

Bertie's notion was superstition all
ht, but it seemed to me pretty note-
rthy. It showed that folk belief is
just wild imagining but is more
en the result of an honest effort
put two and two together. In this
e, the myth probably arises from
combination of two observations
t the coastal people have made.
e is that the bite of a snake that
just fed is less likely to be severe
n that of a hungry snake. This
y be partly because poison is used
in feeding, partly because more
son is secreted by a hungry snake,
l partly because the virulence of
poison of an unfed snake may be
her. Whatever the real reason, the
uth-washing belief rests on age-
g, and valid, observation of the
relation between a mild bite and
'ball in the belly" of the snake.
th no books or herpetologists
und, it is little wonder that the
l cause of the correlation is over-
ked and a more picturesque expla-
ion adopted. The belief is rein-
ced by the other observation,
ich is that *terciopelos* do anoma-
sly turn up on the beach, where
y are no doubt returning to land
er having been rafted out of river
uths on floating debris.

It was really the *curandera* telling
matter-of-factly about the snake-
in treatment that set me to won-
ing how sensible people like the
rtuguereños ever came by the seeming nonsense of their snakebite remedies. Two factors make it turn out that way, I think. One is the desperation of having no other recourse than your own experience and imagination, and those of your forebears and neighbors. The other is the apparently high frequency of false bites that *terciopelos* deliver. In fact, an important basis for all bush cures for snakebite—a factor that keeps intelligent people believing in them—may be the frequency of cases in which no venom or small quantities of venom are injected when the bite glances or hits a bone or otherwise misfires, and patients get well in spite of the treatment. The disaster of a full *terciopelo* bite in country without medical help would lead anyone to grasp at straws, to accept a neighbor's treatment without demanding to know how it works, simply because it is all there is. And if the incidence of aborted bites is high enough, the cure would be bound to take hold as part of the folk medicine of the country. If generations keep getting 40 per cent recovery from snake brains, kerosine, and chewing tobacco, they have to be unnaturally skeptical not to stick to these as treatment. Modern medicine has few specifics that cure at such a rate.

Those ideas appear to apply better to the bites of *Bothrops atrox* than to those of, say, the rattlesnakes. I never heard of anybody being bitten by a diamondback, hard and squarely on an unprotected surface, and showing no symptoms of poisoning. So the next question is, why does the fer-de-lance, one of the most dangerous, poisonous snakes on earth, deliver false bites? The answer is unknown.

But why might it not be that the *terciopelo*, a big viper that eats little rodents and kills them by injecting venom, has evolved the useful trait of bluffing oversized, inedible intruders by striking with fangs folded, instead of by stabbing them with its elegantly long, thin teeth? When Harold Hirth was down at Tortuguero he measured a lot of *terciopelo* fangs and found that they are longer, per foot of snake, than those of any American viper except perhaps the bushmaster. A six-foot *atrox* has fangs just about an inch long. They are also exceedingly slender, and surprisingly easy to snap off. So the bluffing-bite theory might go on to

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suggest that the 20-odd kinds of rattlesnakes don't abort their strikes because they can avoid unnecessary fang damage and waste of poison by bluffing in another way: by rattling. That is, having a rattle to sound allows a rattlesnake to advertise its presence and identity to big, inedible, hard-footed animals, and so, to avoid both the hazard of being stepped on and the useless loss of teeth and venom. The cottonmouth does the same thing by opening wide his cotton-white mouth, you could go on to say. Why the copperhead has not faced up to this problem I can't suggest—maybe it has. Anyway, very few people are hurt by copperheads. Also, the theory leaves nothing said about the host of other fang-folding vipers of the American tropics and of the Old World. But that is no reason not to try to explain the false bites of the viper at hand, nor to see in its fantastically elongate, delicate, brittle teeth an asset too dear to squander on the shinbone of a tapir. Man, of course, is too recently arrived in *Bothrops* country to have been involved in the evolution of the tendency; but now that he is there, he no doubt falls in with the other creatures that seem, to the snake, too big to swallow and too heavy to be stepped on by. For a *terciopelo* to strike, out of fear or anger, at the legs of peccaries, tapirs, or deer—or johnny-come-lately American man—might not have enough survival advantage to outweigh the inconvenience of broken-off fangs, even though these are quickly replaced by spare ones. Going no farther afield than the *terciopelo* and the rattlesnakes, one might sum this up by suggesting that the latter protects its fangs and husbands its venom by rattling, and when the warning fails, strikes always to inject poison. The fer-de-lance, on the other hand, having no rattle, strikes to stab a big intruder only when it feels clearly hard-pressed, and delivers fangless strikes when the need is just to scare somebody badly. Anyway, that is what I have been stirred to think; and I hope it is not just moonshine from excess adrenaline let loose by the recollection of my *Bothrops* bite.

Archie Carr is Professor of Zoology at the University of Florida. He is the author of "The Windward Road" and "So Excellent a Fishe."

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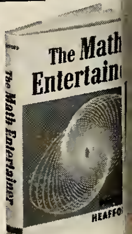

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he Myth of The Peaceful Atom

Continued from page 16

iles from a major city, many of to- orrow's atomic plants will be much oser. Although the AEC has drafted uidelines" for siting reactors, the ommission has failed to make utili- es adhere to them. In 1967, Clifford Beck, AEC's Deputy Director of egulation, admitted to the Joint ommittee on Atomic Energy that uclear plants in Connecticut, Cali- rnia, New York, and other loca- ons "have been approved with low- distances than our general guides ould have indicated when they were proved."

Also, we must remember that hile a reactor may not be near the gal boundaries of a metropolis, it ay lie close to a population center. hus, while Con Edison's Indian oint plant is 24 miles from New ork City (two more plants are w being built there), it is within) miles of an estimated population 155,510. It need only be recalled at the Brookhaven Report foresaw eople being killed by a major radio- tive release at distances up to 15 iles to realize the significance of ese figures.

In a recent study of nuclear plant ting made by W. K. Davis and J. E. obb of San Francisco's Bechtel orporation, the locations of 42 nu- ear power plants (some proposed, me now operable) were examined ith respect to population centers habited by 25,000 residents or ore. Their findings are unnerving: ly *two* plants in operation or anned are more than 30 miles from population center. Of the rest, 14 e between 20 and 27 miles away, 5 between 10 and 16 miles, and 11 etween 1 and 9 miles.

Is it necessary to build atomic lants so big and so close? The an- wer has to do with economics. The rger a facility is, the lower the unit ost of construction and operation nd the cheaper the electricity. The nger the fuel cycle, the fewer the pensive shutdowns while spent fuel semblies are replaced. The closer e plant is to the consumer, the wer the cost of rights of way, power nes, and other transmission equip- ent.

On a few occasions an aroused ublic has successfully opposed the tuation of plants near population enters. When the Pacific Gas and Electric Company persisted in trying to build a reactor squarely over earthquake faults in an area of known seismic activity—the site was Bodega Head, north of San Francisco—a courageous conservation group forced the company to back down. It has been suggested, though, that the group might not have won had not the Alaskan earthquake of 1964, occurring while the fight was going on, underscored the recklessness of the utility's scheme.

Announcement by Con Edison at the end of 1962 of its proposal to build a large nuclear plant in Ravenswood, Queens, close to the center of New York City brought a storm of frightened and angry protest. Although the utility's chairman noted, "We are confident that a nuclear plant can be built in Long Island City, or in Times Square for that matter, without hazard to our own employees working in the plant or to the community," David E. Lilienthal, the former head of the AEC, had a contrary opinion, declaring he "would not dream of living in Queens if a huge nuclear plant were located there." Outraged citizens and a number of noted scientists prevailed.

For the most part, however, the battle has been a losing one. Con Edison, for example, after its defeat in the Ravenswood fight, has just announced an interest in building a reactor on Welfare Island, literally a stone's throw from midtown Manhattan. Also, New York's Governor Nelson Rockefeller has gone on record advocating an $8 billion electric power expansion program based extensively on nuclear energy. The state legislature approved of the program, and in 1968, voted to bolster the plan with state subsidies.

Some of the deepest concern about the size and location of atomic plants has been expressed by members of the AEC themselves. "The actual experience with reactors in general is still quite limited," said Harold Price, AEC's Director of Regulation, in 1967 congressional hearings, "and with large reactors of the type now being considered, it is nonexistent. Therefore, because there would be a large number of people close by and because of lack of experience, it is . . . a matter of judgment

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and prudence at present to locate reactors where the protection of distance will be present."

Price's statement is mild compared to that made in the same hearings by Nunzio J. Palladino. Chairman of the AEC's Advisory Committee on Reactor Safeguards for 1967, and Dr. David Okrent, former Chairman for 1966: "the ACRS believes that placing large nuclear reactors close to population centers will require considerable further improvements in safety, and that *none of the large power reactors now under construction is considered suitable for location in metropolitan areas* [our italics]."

The threat of a nuclear plant catastrophe constitutes only half of the double jeopardy in which atomic power has placed us. For even if no such calamity occurs, the gradual exhaustion of what one scientist terms our environmental "radiation budget," due to unavoidable releases of radioactivity during normal operation of nuclear facilities, poses an equal and possibly more insidious threat to all living things on earth.

Most of the fission products created in a reactor are trapped. Contaminated solids, liquids, and gasses are isolated, allowed to decay for a short period of time, then concentrated and shipped in drums to storage areas. These are called "high-level wastes." But technology for retaining all radioactive contaminants, is either unperfected or costly, and much material of low-level radioactivity is routinely released into the air or water at the reactor site. These releases are undertaken in such a way, we are told, as to insure dispersion or dilution sufficient to prevent any predictable human exposure above harmful levels. Thus, when atomic power advocates are asked about the dangers of contaminating the environment, they imply that the relatively small amounts of radioactive materials released under "planned" conditions are harmless.

This view is a myth.

In the first place, many waste radionuclides take an extraordinarily long time to decay. The half-life (the time it takes for half of an element's atoms to disintegrate through fission) of strontium-90, for instance, is more than 27 years. Thus, even though certain long-lived isotopes are widely dispersed in air or diluted in water, their radioactivity does n cease. It remains, and over a peri of time accumulates. It is therefo not pertinent to talk about the saf of any single release of "hot" eff ents into the environment. At iss rather, is their duration and cumu tive radioactivity.

Further, many radioactive e ments taken into the body tend build up in specific tissues and gans to which those isotopes are tracted, increasing by many tim the exposure dosage in those lo areas of the body. Iodine-131, for stance, seeks the thyroid glan strontium-90 collects in the bone cesium-137 accumulates in musc Many isotopes have long half-liv some measurable in decades.

Two more factors controvert t view that carefully monitored r leases of low-level radioactivity in the environment are not pernicio First, there is apparently no radi tion threshold below which harm impossible. Any dose, however sma will take its toll of cell material, a that damage is irreversible. Secon it may take decades for organic da age, or generations for genetic da age, to manifest itself. In 1955, f example, two British doctors r ported a case of skin cancer—ul mately fatal—that had taken fort nine years to develop followi fluoroscopic irradiation of a patie

Still another problem has receiv inadequate attention. Man is by n means the only creature in who radioactive isotopes concentrate. Th dietary needs of all plant and anim life dictate intake of specific el ments. These concentrate even in th lowest and most basic forms of lif They are then passed up food chain from grass to cattle to milk to ma for example. As they progress u these chains, the concentrations ofte increase, sometimes by hundreds o thousands of times. And if these ele ments are radioactive. . . .

Take zinc-65, produced in a rea tor when atomic particles intera with zinc in certain components Scrutiny of the wildlife in a pond re ceiving runoff from the Savanna River Plant near Aiken, South Caro lina, disclosed that while the wate in that pond contained only infini tesimal traces of radioactive zinc-65 the algae that lived on the water ha concentrated the isotope by nearl 6,000 times. The bones of bluegills

omnivorous fish that feeds both
algae and on algae-eating fish,
wed concentrations more than
00 times higher than the amount
nd in the water. Study of the Co-
nbia River, on which the Hanford,
shington, reactor is located, re-
led that while the radioactivity of
water was relatively insignifi-
t: 1. the radioactivity of the river
nkton was 2,000 times greater; 2.
radioactivity of the fish and
cks feeding on the plankton was
,000 and 40,000 times greater, re-
ctively; 3. the radioactivity of
ung swallows fed on insects caught
their parents near the river was
0,000 times greater; and 4. the
lioactivity of the egg yolks of
ter birds was more than a million
es greater.

Here then are clear illustrations
the ways in which almost unde-
table traces of radioactivity in air,
ter, or soil may be progressively
centrated, so that by the time it
ds up on man's plate or in his glass
s a tidy package of poison.

That nuclear facilities are pro-
cing dangerous buildups of radio-
topes in our environment can be
ply documented. University of
vada investigators, seeking a
se for concentrations of iodine-
1 in cattle thyroids in wide areas
the western United States, con-
ded that "the principal known
rce of I-131 that could contribute
this level is exhaust gases from
clear reactors and associated fuel-
cessing plants."

In his keynote address to the
alth Physics Society Symposium
Atlanta, Georgia, early in 1968,
C Commissioner Wilfred E. John-
admitted that the release into the
nosphere of tritium and noble
ses such as krypton-85 would pre-
t a potential problem in the fu-
e, and that, as yet, scientists had
t devised a way of solving it.
ypton-85, although inert, has a 10-
r half-life and tends to dissolve
fatty tissue, meaning fairly even
tribution throughout the human
dy. Krypton-85 is particularly dif-
ult to filter out of reactor dis-
arges, and the accumulation of this
ment alone may exhaust as much
two-thirds of the "average" hu-
n's "radiation budget" for the
ning century, based on the stand-
ls established by the National
mmittee on Radiation Protection
l Measurement.

That "low-level" waste is a grossly deceptive term is obvious. In his book *Living with the Atom,* author Ritchie Calder in 1962 described an "audit" of environmental radiation that he and his colleagues, meeting at a symposium in Chicago, drew up to assess then current and future amounts of radioactivity released into atmosphere and water. Speculations covered the period 1955–65, and because atomic power plants were few and small during that time, the figures are more significant in relation to the future. Tallying "planned releases" of radiation from such sources as commercial and test reactors, nuclear ships, uranium mills, plutonium factories, and fuel-reprocessing plants, Calder's group came to a most disquieting conclusion: "By the time we had added up all the curies which might predictably be released, by all those peaceful uses, into the environment, it came to about 13 million curies per annum." A "curie" is a standard unit of radioactivity whose lethality can be appreciated from the fact that one trillionth of one curie of radioactive gas per cubic meter of air in a uranium mine is ten times higher than the official maximum permissible dose.

Calder's figures did not include fallout due to bomb testing and similar experiments, nor did they take into account possible reactor or nuclear transportation accidents. Above all, they did not include possible escape of stored high-level radioactive wastes, the implications of which were awesome to contemplate: "what kept nagging us was the question of waste disposal and of the remaining radioactivity which must not get loose. We were told that the dangerous waste, which is kept in storage, amounted to 10,000 million curies. If you wanted to play 'the numbers game' as an irresponsible exercise, you could divide this by the population of the world and find that it is over 3 curies for every individual."

Exactly what does Calder mean by "the question of waste disposal"?

It has been estimated that a ton of spent fuel in reprocessing will produce from forty to several hundred gallons of waste. This substance is a violently lethal mixture of short- and long-lived isotopes. It would take five cubic miles of water to dilute the waste from just *one* ton of fuel to a

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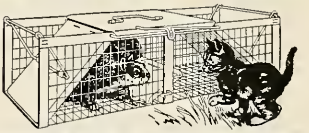

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safe concentration. Or, if we permitted it to decay naturally until it reached the safe level—and the word "safe" is used advisedly—just one of the isotopes, strontium-90, would still be damaging to life 1,000 years from now, when it will have only one seventeen-billionth of its current potency.

There is no known way to reduce the toxicity of these isotopes; they must decay naturally, meaning *virtually perpetual containment.* Unfortunately, mankind has exhibited little skill in perpetual creations, and procedures for handling radioactive wastes leave everything to be desired. Formerly dumped in the ocean, the most common practice today is to store the concentrates in large steel tanks shielded by earth and concrete. This method has been employed for some twenty years, and about 80 million gallons of waste are now in storage in about 200 tanks. This "liquor" generates so much heat it boils by itself for years. Most of the inventory in these caldrons is waste from weapons production, but within thirty years, the accumulation from commercial nuclear power will soar if we embark upon the expansion program now being promoted by the AEC. Dr. Donald R. Chadwick, chief of the Division of Health of the U.S. Public Health Service, estimated in 1963 that the accumulated volume of waste material would come to two billion gallons by 1995.

It is not just the volume that fills one with sickening apprehension but the techniques of disposing of this material. David Lilienthal put his finger on the crux of the matter when he stated: "These huge quantities of radioactive wastes must somehow be removed from the reactors, must—without mishap—be put into containers that will never rupture; then these vast quantities of poisonous stuff must be moved either to a burial ground or to reprocessing and concentration plants, handled again, and disposed of, by burial or otherwise, with a risk of human error at every step." Nor can it be stressed strongly enough that we are not discussing a brief danger period of days, months, or years. We are talking of periods "longer," in the words of AEC Commissioner Wilfred E. Johnson, "than the history of most governments that the world has seen."

Yet already there are many instances of the failure of storage
ities. An article in an AEC pul
tion has cited nine cases of
failure out of 183 tanks locate
Washington, South Carolina,
Idaho. And a passage in the A
authorizing legislation for
called for funding of $2,500,00
the replacement of failed and fa
tanks in Richland, Washing
"There is no assurance," concl
the passage, "that the need for
waste storage tanks can be
stalled." If this is the case after t
ty years of storage experience,
beyond belief that this burden
be borne without some storage
ures for centuries in the future.
member too, that these waste-h
ing "tank farms" are vulnerabl
natural catastrophes such as ea
quakes, and to man-made ones
as sabotage.

Efforts are of course being m
toward effective handling of
waste problems, but many techn
barriers must still be overcome.
unlikely they will all be overc
by the end of the century, when w
tanks will boil with 6 billion cu
of strontium-90, 5.3 billion cu
of cesium-137, 6.07 billion curies
prometheum-147, 10.1 billion cu
of cerium-144, and millions of cu
of other isotopes. The amount
strontium-90 alone is 30 times m
than would be released by the
clear war envisioned in a 1959 c
gressional hearing.

The burden that radioact
wastes place on future generation
cruel and may prove intoleral
Physicist Joel A. Snow stated it w
when he wrote in *Scientist and C*
zen: "Over periods of hundreds
years it is impossible to ensure t
society will remain responsive to
problems created by the legacy
nuclear waste which we have l
behind."

"Legacy" is indeed a gracious w
of describing the reality of this si
ation, for at the very least we a
saddling our children and th
descendants with perpetual cus
dianship of our atomic refuse, and
worst may be dooming them to t
same agonizing afflictions and deat
suffered by those who survived Hi
shima. Radiation has been positive
linked to cancer, leukemia, bra
damage, infant mortality, catarac
sterility, genetic defects and mut
tions, and general shortening of li

he implications for the survival aankind can be glimpsed by conring just one of these effects, the etic. In a 1960 article, James F. w, Professor of Genetics at the versity of Wisconsin School of licine and president of the Gecs Society of America, stated that every roentgen of slow radiation e kind we can expect to receive in easing doses from peacetime nur activity—about five mutations result per 100 million genes exed, meaning that "after a number generations of exposure to one ntgen per generation, about one ,000 . . . in each generation would e severe genetic defects attribut to the radiation."

he Atomic Energy Commission ware of the many objections that e been raised to the atomic power gram: why does it continue to ourage it? Unfortunately, the nmission must perform two coning roles. On the one hand, it is ponsible for regulating the atomic ver industry. But on the other, it been charged by Congress to prote the use of nuclear energy by the ity industry. Because of its invement in the highest priorities national security, enormous ver and legislative advantages e been vested in the AEC, ening it to fulfill its role as proter with almost unhampered cess—while its effectiveness as ulator has gradually atrophied. Commission consistently denies ms that atomic power is heading troubled waters, optimistically ssuring critics that these plants safe, clean neighbors.

he fact that there is no foundan for this optimism is emphasized the insurance situation on atomic ilities. Despite the AEC's own astion that as much as $7 billion in perty damage could result from atomic power plant catastrophe, insurance industry, working ough two pools, will put up no re than $74 million, or about one cent, to indemnify equipment nufacturers and utility operators inst damage suits from the pub The federal government will add to $486 million more, but this l leaves more than $6 billion in perty damages to be picked up by tims of a Brookhaven-sized accint. And no insurance company— even Lloyds of London—will issue property insurance to individuals against radiation damage. If there is so little risk in atomic power plants, why is insurance so inadequate?

The knowledge that man must henceforth live in constant dread of a major nuclear plant accident is disturbing enough. But we must recognize that even if such calamities are averted, the slow saturation of our environment with radioactive wastes will nevertheless be raising the odds that you or your heirs will fall victim to one of a multitude of afflictions. There is no "threshold" exposure below which we can feel safe.

We have little time to reflect on our alternatives, for the moment must soon come when no reversal will be possible. Dr. L. P. Hatch of Brookhaven National Laboratory vividly made this point when he told the Joint Committee on Atomic Energy: "If we were to go on for 50 years in the atomic power industry, and find that we had reached an impasse, that we had been doing the wrong thing with the wastes and we would like to reconsider the disposal methods, it would be entirely too late, because the problem would exist and nothing could be done to change that fact for the next, say, 600 or a thousand years." To which might be added a sobering thought stated by Dr. David Price of the U.S. Public Health Service: "We all live under the haunting fear that something may corrupt the environment to the point where man joins the dinosaurs as an obsolete form of life. And what makes these thoughts all the more disturbing is the knowledge that our fate could perhaps be sealed twenty or more years before the development of symptoms."

What must be done to avert the perils of the peaceful atom? A number of plans have been put forward for stricter regulation of activities in the nuclear utility field, such as limiting the size of reactors or their proximity to population concentrations or building more safeguards. As sensible as these proposals appear on the surface, they fail to recognize a number of important realities: first, that such arrangements would probably be opposed by utility operators and the government due to their prohibitively high costs. Since our government seems to be committed to making atomic power plants com-

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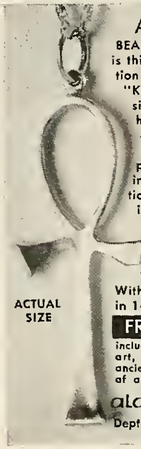

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petitive with conventionally fueled plants, and because businesses are in business for profit, it is hardly likely they would buy these answers. Second, the technical problems involved in containment of radioactivity have not been successfully overcome, and there is little likelihood they will be resolved in time to prevent immense and irrevocable harm to our environment. Third, the nature of business enterprise is unfortunately such that *perfect* policing of the atomic power industry is unachievable. As we have seen in the cases of other forms of pollution, the public spirit of men seeking profit from industrial processes does not always rise as high as the welfare of society requires. It is unwise to hope that stricter regulation would do the job.

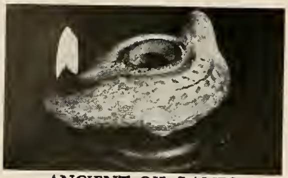
What, then, is the answer? The only course may be to turn boldly away from atomic energy as a major source of electricity production, abandoning it as this nation has abandoned other costly but unsuccessful technological enterprises.

There is no doubt that, with this nation's demand for electricity doubling every decade, new power sources are urgently needed. Nor is there doubt that our conventional fuel reserves—coal, oil, and natural gas—are rapidly being consumed. Sufficient high-grade fossil fuel reserves exist, however, to carry us to the end of this century; and new techniques for recovering these fuels from secondary sources such as oil shale could extend the time even longer. Furthermore, advances in pollution abatement technology and revolutionary new techniques, now in development, for burning conventional fuels with high efficiency, could carry us well into the next century with the fossil fuels we have. This abundance, and potential abundance, gives us at least several decades to survey possible alternatives to atomic power, select the most promising, and develop them on an appropriate scale as alternatives to nuclear power. Solar energy, tidal power, heat from the earth's core, and even garbage and solid-waste incineration have to some degree been demonstrated as promising means of electricity generation. If we subsidized research and development of those fields as liberally as we have done atomic energy, some of them would undoubtedly prove to be what atomic energy once promised,
out its deadly drawbacks.

Aside from the positive pr
of profitability in these ne
proaches, industry will have a
powerful incentive for turni
them; namely, that atomic ene
proving to be quite the oppos
the cheap, everlasting resourc
visioned at the outset of the a
age. The prices of reactors and
ponents and costs of constru
and operation have soared in th
few years, greatly damaging nu
power's position as a competitor
conventional fuels. If insurance
miums and other indirect subs
are brought into line with rea
estimates of what it takes to
atomic energy both safe and eco
ical, the atom might prove to b
most *expensive* form of energy y
vised—not the cheapest. In addi
because of our wasteful fuel poli
evidence indicates that source
low-cost uranium will be exhau
before the turn of the cent
Fuel-producing breeder reactor
which the nuclear establishment
invested such high hopes for the
ation of vast, new fuel supplies,
proven a distinct technological
appointment. Even if the probl
plaguing this effort were overcomi
the next ten or twenty years, it
still be too late to recoup the losse
nuclear fuel reserves brought al
by prodigious mismanagement.

The proposal to abandon or sev
ly curtail the use of atomic ene
is clearly a difficult one to imag
We have only to realize, howe
that by pursuing our current civi
nuclear power program, we are
pardizing every other industry in
country; in that light, this prop
becomes the only practical alter
tive. In short, the entire natio
community stands to benefit fr
the abandonment of a policy wh
seems to be leading us toward both
vironmental and economic disast

Man's incomplete understand
of many technological principles a
natural forces is not necessarily
his discredit. Indeed, that he l
erected empires despite his limi
knowledge is to his glory. But that
pits this ignorance and uncertain
and the fragile yet lethal technolo
he has woven out of them, against t
uncertainties of nature, science, a
human behavior—this may well be
his everlasting sorrow.



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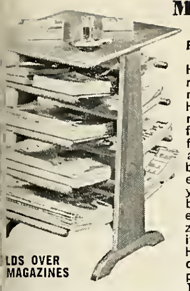

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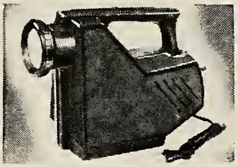

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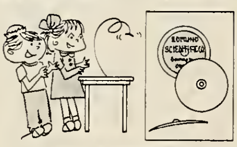

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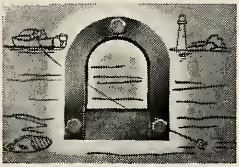

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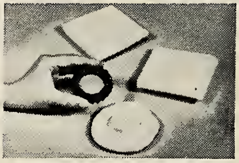

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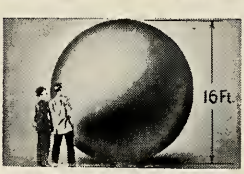

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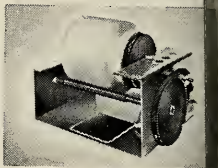

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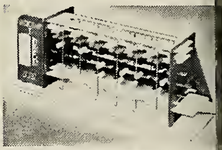

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with the money.
st, Luz Marina's immediate
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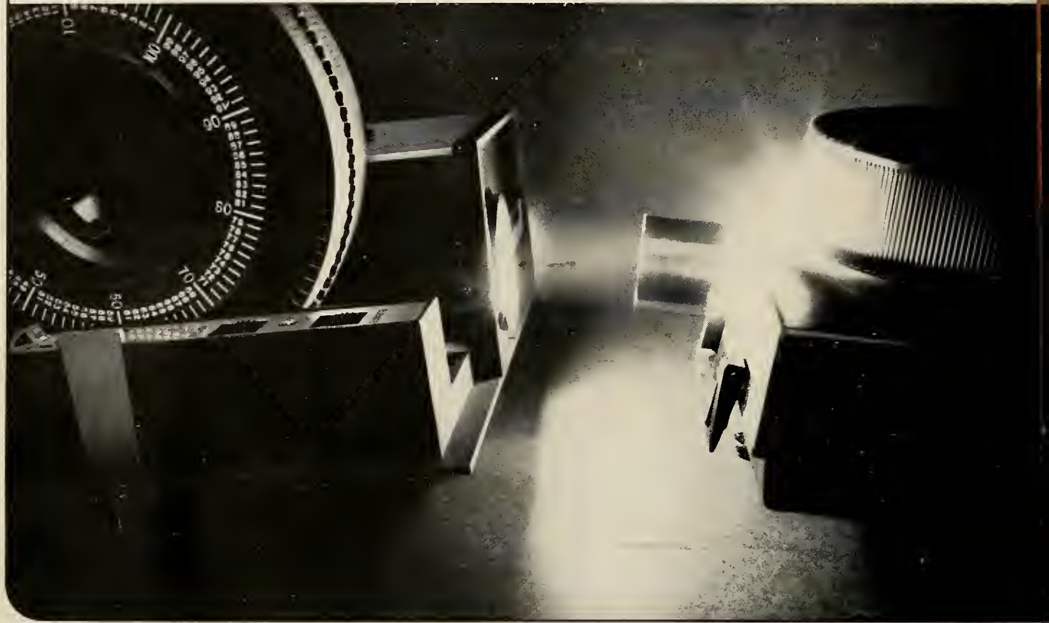

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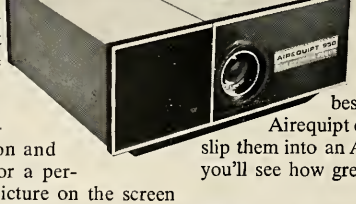

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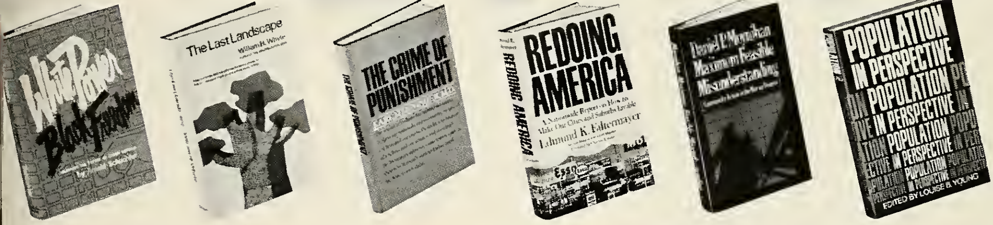

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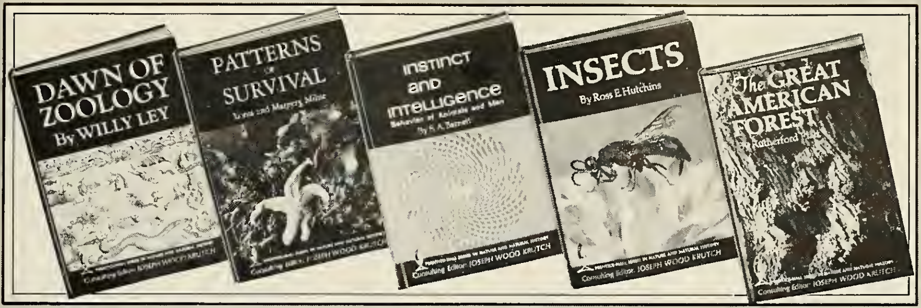
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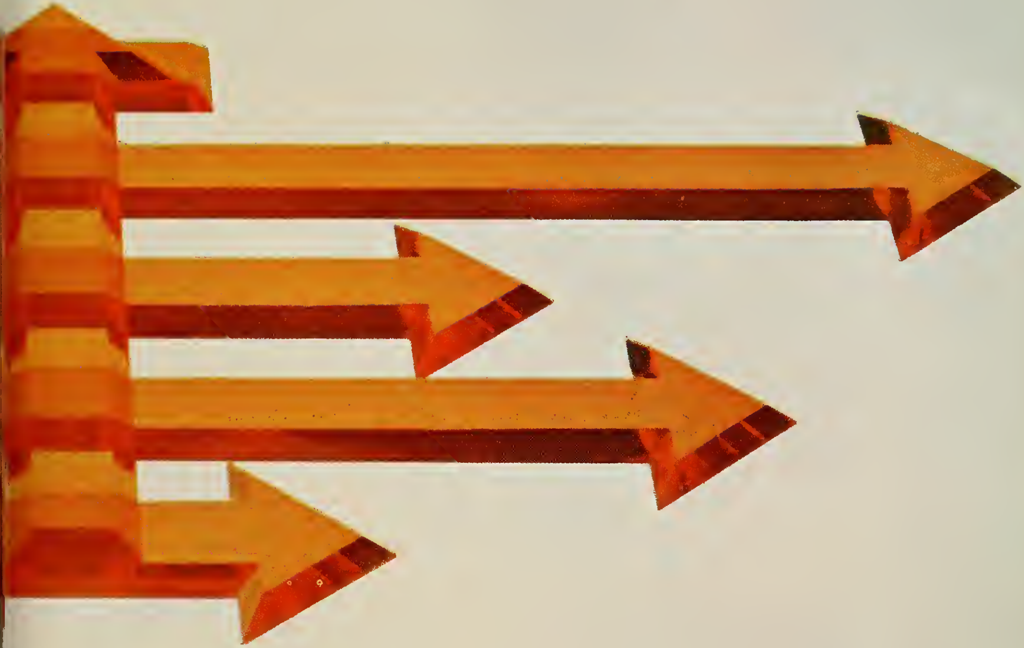

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THE AUTHORS

Cultural anthropologist, psychologist, writer, lecturer, and teacher—**Margaret Mead** was chosen to deliver this year's "Man and Nature" lectures at The American Museum. Her article, "A Working Paper for Man and Nature," is drawn from these talks. For more than forty years, Dr. Mead has been involved in the study and interpretation of subjects that range from primitive cultures of the South Pacific to contemporary society in the United States. Currently Curator of Ethnology at The American Museum and adjunct Professor of Anthropology at Columbia University, Dr. Mead will formally end her 43-year association with the Museum next year. Although she will keep her office in the Museum, she will establish a department of anthropology at Fordham University.

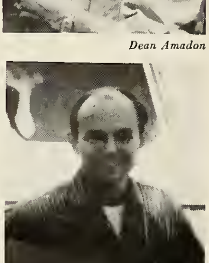
No one here seems to know whether, in his Hoboken and New York City days, Thoreauvian naturalist and writer **Edward Abbey** traveled far enough uptown to visit The American Museum. Chances are he did, since the only places in New York where you can get a real feeling of the Southwest are in several of the Museum's dioramas. And Abbey likes the desert. His book, *Desert Solitaire,* emphatically says so. He is now a Seasonal Park Ranger at Organ Pipe Cactus National Monument in Arizona.

Margaret Mead

Edward Abbey

Dean Amadon

Alexander B. Klots



Christopher J. Schuberth

Ian McHarg, a landscape architect, has produced regional plans for the Baltimore area, Washington, Staten Island, the Hudson Valley, and the St. Paul-Minneapolis region—all of which reflect his conviction that the natural design of the land and its ecology should dictate how it is developed. Mr. McHarg, who teaches landscape architecture and regional planning at the University of Pennsylvania, has also hosted the television series, "The House We Live In," a discussion program on man and the environment. "What would you do with, say, Staten Island?" is taken from Mr. McHarg's forthcoming book, *Design with Nature,* to be published in May by Natural History Press.

Frances Low, whose sketch of Andrew Haswell Green introduces Ian McHarg's article, is a free-lance writer. She is married to New York City Councilman Robert Low, a candidate for the mayoral nomination.

Ian McHarg

Herndon G. Dowlin

Dean Amadon's major area ornithological research has been t evolution of Pacific birds. In "Got am's Birds," however, Dr. Amad turns to his own environment a presents a description of avian l in New York City. Chairman of t Department of Ornithology at T American Museum, Dr. Amadon also Lamont Curator of Bird a collection of more than 800,0 specimens, the world's second la est. Dr. Amadon, who is a form president of the American Ornitho gists' Union, is coauthor of the new published *Eagles, Hawks and Falco of the World.*

A Research Associate in the I partment of Entomology at T American Museum, **Alexander Klots** writes of the changing ins population of "Manhattanik"—l birthplace. Dr. Klots is curren monographing North American s webworm moths at the Museum, l he has also done entomological fi work—including three years of search on malaria control—in su places as the Arctic, Mexico, t Caribbean, Brazil, and parts f Europe. Dr. Klots has also writ *A Field Guide to the Butterflies, T World of Butterflies and Moths,* a with Elsie B. Klots, *Living Insects the World.*

Christopher J. Schuberth, L turer in Geology at The Americ Museum, has examined and stud much of the rock history of the m ropolitan New York region. His ticle is adapted from his book, *T Geology of New York City and E virons,* published in 1968 by Natu History Press. In addition to writi several magazine articles, includi "The Hudson's Six Geologies" NATURAL HISTORY (January, 196 Mr. Schuberth coauthored *Disc ering Rocks and Minerals* and is c rently writing *The Geology of Lo Island.*

"Urban Snakes: An Identity C sis" is one of more than a hund technical and popular articles snakes written by **Herndon Dowling**. Formerly Curator of R tiles at the New York Zoologi Park, Dr. Dowling is now a Resea Associate in Herpetology and director of a special bibliograp project on reptiles at The Americ Museum.

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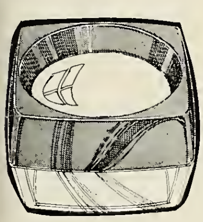

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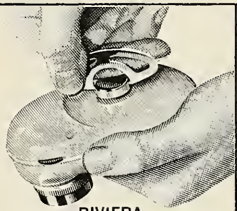

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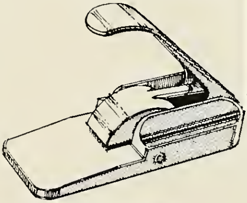

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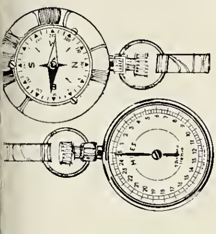

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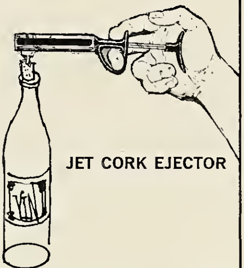

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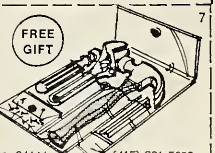

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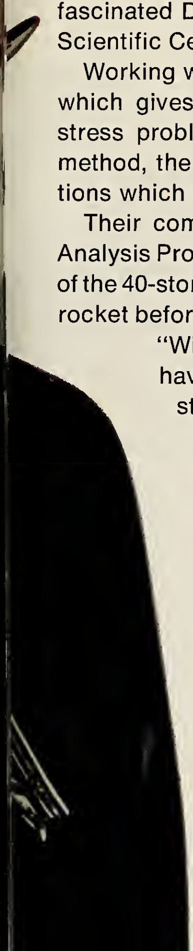

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In and Out of the Field

by Alfred Meye

The Animal Kingdom Ball

New York and the rest of the country/world are probably on the brink of catastrophe. The unmistakable rumble of distant cannons grows daily louder. There is much scurrying about. Warnings pierce the air. The people—scholars, old fishermen, clergymen, journalists, salesmen—are beset with complaints and depression. Taxes soar and the roads are choked with cars. The young revolt. Increasingly, we collide with one another, like the molecules in a warming container of gases.

With disaster so imminent, and with no place in mind to escape to, what could be more soothing and more productive of fantasy than a notice in the New York *Daily News* that there would take place one Thursday evening, for the benefit of the American Society for the Prevention of Cruelty to Animals, a dinr dance called the Animal Kingdo Ball?

Visions of contented beasts flash in my brain. Here, I imagined, most in my own backyard, wou take place perhaps the most pea able event in the history of life—t culmination, the fulfillment, t apotheosis of organic evoluti

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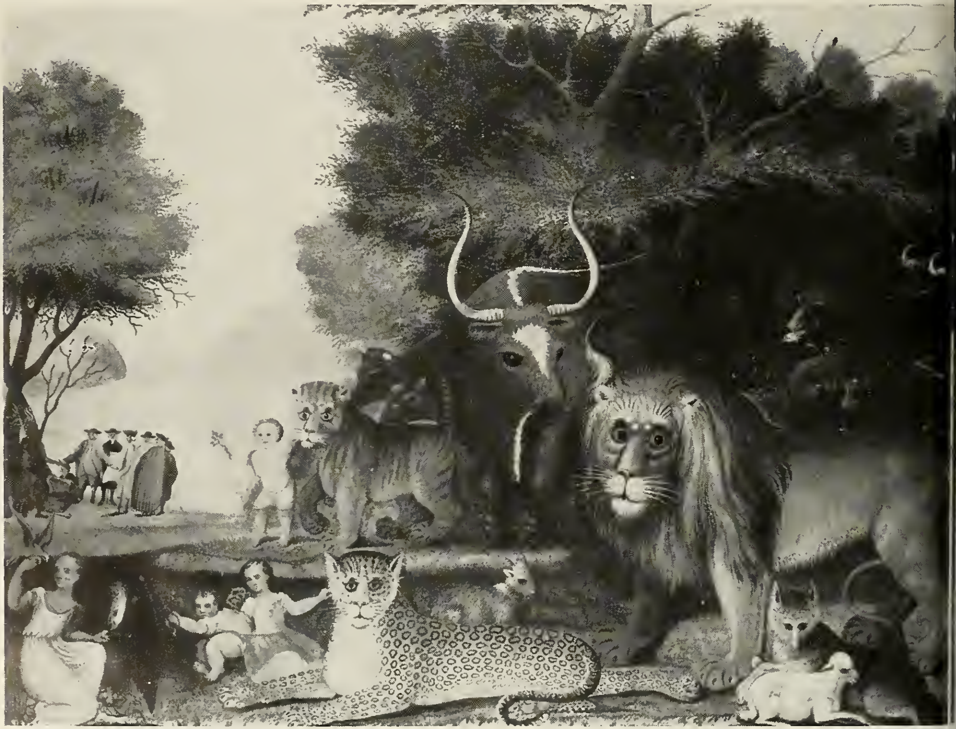

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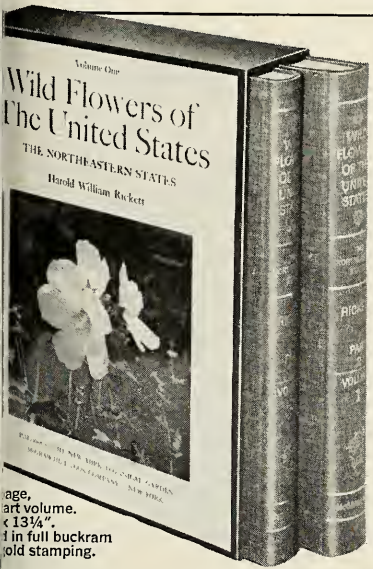

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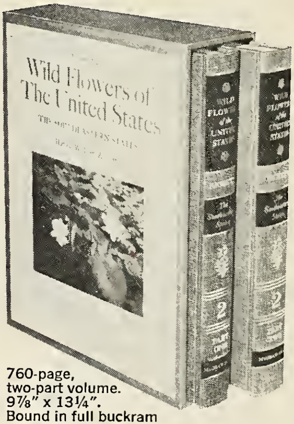

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A Working Paper for Man and Nature

by Margaret Mead

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e other castes to which they do
and cannot belong. If a child
ngs to a group whose total mem-
hip is a few hundred people, the size of the group will also be expressed in the way those about him treat him, in the certainty, for example, that all adults know who he is. So a mother in the isolated mountains of Kentucky places her child with his back against her body, facing out, toward a circle of known kin, but as she moves away from this small, intimately known world, she turns the child around, facing in, toward her protecting body, away from the strangers whose gaze will reinforce her gesture: and from both gaze and gesture, the child will learn about a different kind of world, a world in which most human beings are strangers. Among the seagoing Manus of New Guinea, a mother lifts her baby onto her back. She includes in the tension of her arm the way the baby must hold on, so that her arms will be free to punt or paddle, and the distances over which her eye will range as she does so. Wide horizons of sea or snow or the closed walls of the jungle or the mountain valley are included in every touch the child experiences. The Greek peasant who names his son Daedalus includes the era of the old gods, while the name Constantine, which is given his other son, includes the era after the gods had left Greece and Christianity had come.

If we speak in terms of conscious educational processes, then we can discuss the moment when a child learns geography or the metric system, the meaning of the secret ballot or the graduated income tax. Formal education proceeds along these lines of consciousness; what the school is believed to teach is labeled and compartmentalized. not known until it is encountered in a classroom or in a book. But this applies only to learning that has been identified and tagged. Actually the child in a culture in which arithmetic and geometry are so recognized, encounters them both. early on, in the way in which his parents and brothers and sisters play with him—"one, two, buckle my shoe: three, four, shut the door"—and in the square corners of the room. the sharp angles of his crib, and the bouncing of a rubber ball that is a perfect sphere. The father's arm lifting the child high, lifts him up as high as the tallest palm tree, as high as the flight of one of the eagles of Zeus. as high as the recently scaled Mount Everest, as high as a balloon. a jet, a satellite, or tosses him toward the moon.

The grandmother who sings to the child on her lap. includes all that she knows of time. since her ancestors came out of a hole in the ground near the headwaters of the Sepik River, since the gods walked among men. since Jehovah led the children of Israel through the sea. or since Sheridan's riders burned and plundered a hundred years ago. The child in her arms receives, as she holds him, all of time and space that she herself grasps, or knows that she does not grasp. He receives her knowledge

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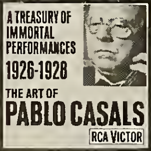
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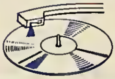

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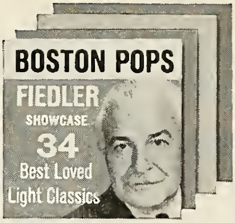
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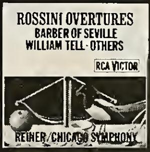
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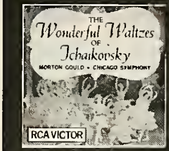
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and her ignorance, as cloth receive a pattern in which the empty, undye spaces are as much a part of th pattern as the filled squares. Toda the physicist father preoccupied wit problems too abstruse to share, h believes, with anyone except perhap three colleagues and two or thre favored students, nevertheless, give his infant son a sense of a world i which so few men know so muc And the poorly educated taxi drive who says to the physicist, "It must b wonderful to understand so muc I have stopped reading the new papers because there is so much th I do not understand," conveys h bewilderment to his son. But th physicist, turning away slight abashed by the honesty and inn cence of the other, will also conve this to his own son as he watch him arrange knives and forks in categories on the floor. The son first steps in learning will look di ferent to his father because of the i nocence and ignorance of the ta driver. If the physicist also know and feels. that for a hundred tho sand years men knew far less th the wistful driver, this too will ent in, as he watches his son traverse path of growth bounded by such di ferent limits than the path his huma ancestors trod: as he realizes th the number *one,* when one can on count to twenty. is the same *one* with its overtones of individuali and singleness—to himself, his chil and to all their ancestors but is al a *one* that is almost incredibly diffe ent. And he will realize that he ca no more wrench his mind back the state of the man who lived in world where no one counted to mo than twenty than his forebears cou project forward to the simplest the mathematics that he knows. Th recognition, in turn, becomes part the way he watches his child, part the tonus of his hand when he li him up, part of the relaxation wh he sets him down.

In every culture, no matter h simple, no matter how complex, matter how impoverished or cayed, how exuberant and efflor cent, the children receive a total i pression. The deepest ignorance a the state of the most esoteric kno edge is conveyed to them, inart ulately, by the way they are he and sung to, fed and punished, p mitted to wander or kept close

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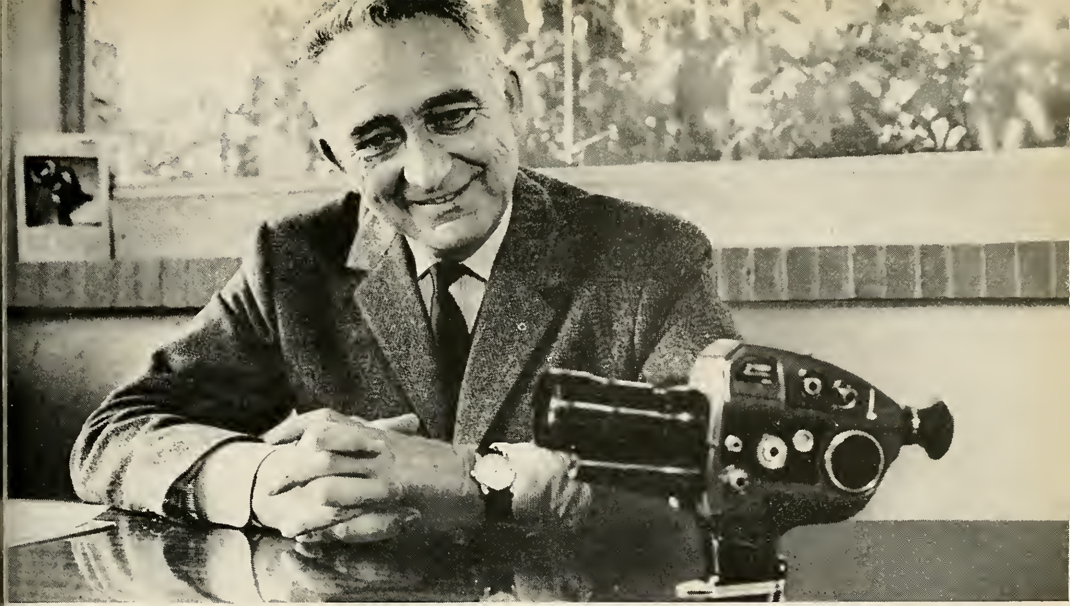
home. But in complex societies like our own they share it very differently; some children receive as their birthright the sense of tremendous knowledge and power over nature that so informs the modern Western world: other children receive it as a sense of power and mastery that they themselves will never have. For some a ride through the stars becomes an easy expectation: for others a daydream. which can be indulged even more freely because it is manifestly unrealizable. As such children grow older. the differences in the way in which they receive the same knowledge in turn generates other kinds of beliefs. And so we get a conversation between two students. one black and one white. in which the black girl says: "Things aren't the same to you that they are to me. You don't see what I see, and I don't see what you see. If you think of an apple, you think of it on a silver platter. while I think of it falling to the ground from a tree." Yet the white girl has never been served an apple on a silver platter, and she, too, grew up in the country and gathered fallen apples from the high grass in the orchard. The experience of each has been screened through the imagined experience of the other. a different pattern laid on each. But both embody the same culture, though in such different ways.

We are on the verge of a tremendous change in the nature of man, a change as far reaching as the great changes of the past. when man's precursors learned to use tools. to speak, to plant seeds. to build cities, and to write. Perhaps an even greater change. One component of that change is the kind of knowledge and the kind of understanding we have about earlier man. It is not only that the complex tools that man uses today. as he moves huge weights or builds a spaceship, are the lineal descendants of earlier tools, or that speech preceded writing; writing, printing; and printing. video. It is not only that the earlier behaviors are included with the later operations we perform so that we simultaneously depend upon techniques that appeared at intervals of thousands of years. This simultaneity gives to all our learning a strange, discrepant, clumsy character, as we use old gestures on new machines, old safeguards where they are not needed, old audacities where they are deadl inappropriate. But perhaps more important still is the question o whether we are able to conceptualize to make conscious and amenable t imagination and reason the paths b which we have come and what the mean in the places where we no are, and the directions we may take Our lack of ability to teach the kin of precision and responsibility tha is essential for the machine age, ha cost, and is costing, millions of lives Our inability to develop new an different centers of decision and authority (for example, for international air travel and control o nuclear weapons) is endangerin mankind and the planet itself. Muc of this can be attributed to the survival of old forms into a new age, t the persistence of old forms of learning when they are no longer appropriate. Much of it is due to our inability to use the older forms o learning constructively. so they become hindrances rather than helps.

But there are dangers in stressin the usefulness and the beauty of th old forms of learning, just as ther are dangers in stressing those tha are no longer relevant. It has bee found that children who depen overmuch on touch. may lose out in world in which sight and sound hav replaced touch and taste and smel as major sensory pathways. Bu there are different ways in which w may respond to this knowledge. W may say: "We have lost somethin extremely precious and we must ge it back, learn to use every sense restore the senses to their once undisputed immediacy, construct world in which there is less dependence upon reason and more dependence upon sense and feeling." Thi is one response to the recognition o discrepancy, to glimpses of the life o fisherfolk or mountaineers, to endearing glimpses, from the safety o a good supply of modern biotics, o the life of Indians in the South American jungle. Or we can recognize tha these ways of our forebears are way to which we can never return, bu that the more we can recapture o this earlier wisdom, in a form we ca understand, the better we can understand what is happening today, whe a generation almost innocent of sense of history has to learn how t cope with an unknown future, on for which they were not reared.



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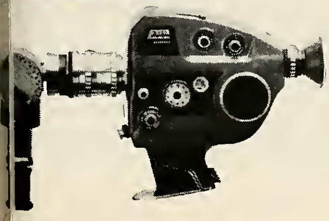

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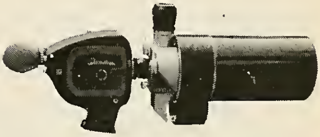

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City of the Prophecies— a Hoboken Perspective

by Edward Abbey

Hoboken is not one of the five boroughs of New York City. But it should be, for it's closer and quicker to the center of Manhattan from Hoboken, New Jersey, than it is from any point in Brooklyn, The Bronx, Queens, or Staten Island. Fifteen minutes by bus, via the Lincoln Tunnel, takes you from Washington Street in Hoboken to the Port Authority Bus Terminal on 41st Street; ten minutes by train via the Tubes takes you from the Erie-Lackawanna Terminal to 9th Street and Sixth Avenue—the Village. A dash under the river, a blast of iron and you're there: in Glitter Gulch, USA—Times Square, The Big Midway, the hanging gardens of electricity. Or down yonder in Green Witch Village, under the very windows of the ladies' detention home. What more could you want? And if New York is not Manhattan it is nothing. A little worse than nothing. Meanwhile the insane, medieval burgs of New Jersey—Union City, West New York, Jersey City—lie divorced from Hoboken by a wall older than the Great Wall of China. I mean the Palisades, that sill of diabase left over from the Triassic period.

I make this effort to incorporate Hoboken with New York City (where it belongs) rather than allowing it to remain in New Jersey (for which it is much too sweet, pure, romantic) because it is from the Hoboken point of view, the Hoboken mystique, the Hoboken metaphysic, that I must describe what I remember and what I know of New York. Meaning Manhattan. Of the rest I know nothing. The other four boroughs are as remote to my imagination as the malebolges of the Eighth Circle of Hell. Perhaps only Dante could tell us the truth about them. Perhaps only Dante—and Dostoyevsky—could tell us the truth about New York.

For two years I lived in Hoboken, far from my natural habitat. The bitter bread of exile. Two years in the gray light and the sulfur dioxide and the smell of burning coffee beans from the Maxwell House plant at the end of Hudson Street. In a dark dank decaying apartment house where the cockroaches, shell-backed, glossy, insolent *Blatella germanica,* festered and spawned under the linoleum on the sagging floors, behind the rippled wallpaper on the sweating walls, and among the teacups in the cupboard. Everywhere. While the rats raced in ferocious packs, like wolves, inside the walls and up and down the cobblestone alleyways which always glistened, night and day, in any kind of weather, with a thin chill greasy patina of poisonous dew. The fly ash everywhere, falling softly and perpetually from the pregnant sky. We watched the seasons come and go in a small rectangle of walled-in space we called our yard: in spring and summer the black grass; in fall and winter the black snow. Overhead and in our hearts a black sun.

Down in the cellar and up in the attic of that fantastic house—four stories high, brownstone, a stoop, wide polished bannisters, brass fittings on the street entrance, a half-sunken apartment for the superintendent, high ceilings, high windows and a grand stairway on the main floor, all quite decently middle class and in the better part of town, near the parks, near the Stevens Institute of Technology—hung draperies of dust and cobweb that had not been seen in the light of day or touched by the hand of man since the time of the assassination of President William McKinley.

In the sunless attic the spiders had long since given up, for all their prey had turned to dust; but the rats roamed freely. Down in the base
ment, built like a dungeon with ceil
ing too low to permit a man o
normal stature to stand erect, ther
were more rats, of course—they love
the heat of the furnace in winter—
and dampish stains on wall and floo
where the great waterbugs, like cock
roaches out of Kafka, crawled slug
gishly from darkness into darkness
One might notice here, at times, th
odor of sewer gas.

The infinite richness. The ecology
the natural history of it all. An excel
lent workshop for the philosopher
for who would venture out into tha
gray miasma of perpetual smoke an
fog that filled the streets if he migh
remain walled up in books, sippin
black coffee, black Russian ciga
ettes, thinking long, black ink
thoughts? To be sure. But there wer
the streets. The call of the streets.

We lived one block from the wate
front. The same waterfront whe
Marlon Brando once played Marlo
Brando, where rust-covered tram
steamers, black freighters, dereli
Dutchmen, death ships, came to ca
under Liberian flags to unload the
bananas, baled hemp, teakwoo
sacks of coffee beans, cowhides, A
gentine beef, and take on kegs
nails, jeep trucks, Cadillacs an
crated machine guns. Abandoned
the Holland-American Line in '65,
least for passenger service, the H
boken docks—like Hoboken bars an
Hoboken tenements—were sinki
into an ever deepening state of deca
The longshoremen were lucky to g
two days' work a week. Some of t
great warehouses had been empty f
years; the kids played Mafia in the

The moment I stepped out t
front door I was faced again wi
Manhattan. There it was, splend
ship of concrete and steel, aluminu

Continued on page

Come talk to the animals.

ttle rhinoceros, banter a baboon or ɜn try to get through to a kongoni. Be- ɹse our two safaris have a lot of the ast in them.

All the big game reserves are on the ıerary. Masai-Mara, the Serengeti ıins, the Ngorongoro Crater (100 square es of elephants, giraffe, zebra, ante- ɪe, gazelle and a pride of lions here and re). There's also Lake Manyara Nation- Park and the Samburu Game reserve.

You'll stop at Professor Leakey's camp see where it all began, too. And hear million gallons of water a minute fall feet over Victoria Falls. You won't be- e the mine dance the Ndebeles do, or height of a Masai warrior in his bare t.

And you'll see southern and eastern ica in comfort. Sleep at the best hotels me with pools), spend a night under a t—or up in a tree house if you choose. vel the plains by Landrover, over the untains by small plane and motor- nch up the rivers. When you get home, 'll know this part of Africa thoroughly.

Talk to your travel agent. Then brush on your rhinoceros.

n Safari. 3 weeks from
$1,804

s escorted tour visits Union of South

PHOTOS BY NORMAN MYERS, NAIROBI.

Africa, Zambia, Rhodesia, Kenya and Tanzania.

Price includes jet round-trip economy from New York, all accommodations, most meals, all safari transportation, guided sightseeing and game viewing, entrance fees to game parks, fees for guides and askaris.

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Uganda, Kenya and Tanzania.

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The problems to be solved for all time are those...of traffic ...methods of carrying people from the suburbs to the center. the supply of pure and wholesome water....Unless the difficulties are soon met by the adoption of a general plan, New York City's embarrassments will have so increased that generation will be found bold enough to grapple with and remedy them.

This seemingly contemporary warning was sounded one hundred years ago by Andrew Haswell Green, the first Comptroller of New York's Central Park. As Comptroller, Green accepted so many donations of animals that they threatened to crowd everything else out of the Arsenal building—which he then set aside to accommodate them exclusively. When a group of citizens with the resoundingly New York names of Jesup, Morgan, Phelps Dodge, Potter, Steward, Bliss, and Roosevelt came to the park board with their proposal for a museum of natural history, Green was ready with a formulated creed:

"The question which now exercises the minds of our thoughtful educators, is how best to introduce the study of nature or the elementary portions of science into the common schools. . . . The duty of education is to bring the pupil into direct relation with things themselves, that he may reflect and exercise judgment upon them. . . . If the objects of nature are to be directly studied they must either be brought to the classroom or the classes must adjourn to the vicinity of things themselves. . . . The time has therefore arrived when the attention of all interested in education in this city may be fitly drawn to the Central Park—to what is already accomplished there, and for what is further preparing to be done, to render it a great storehouse of appliances for the mental improvement of the youth of our city."

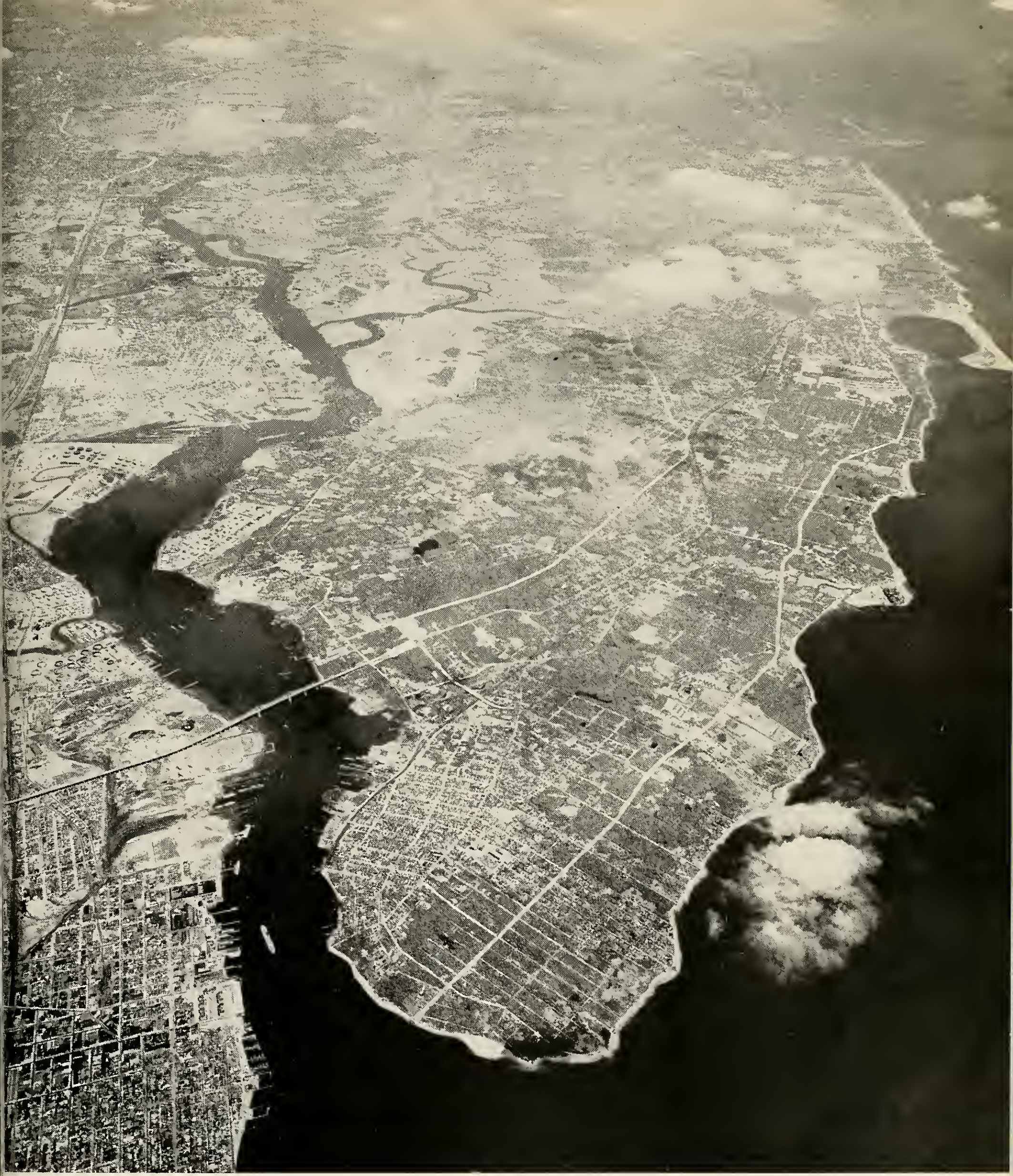
With Green's support, The American Museum of Natural History was founded in April, 1869, locating itself temporarily in Green's overpopulated arsenal. He also harvested for New York the Metropolitan Museum of Art, the meteorological and astronomical observatory, the arboretum and botanical gardens, the public library, and the Bronx Zoo. At the same time, he turned his hand to city planning and, unlike earlier planners who had flattened the hills of the city and stamped down a grid, he worked with the natural terrain. He acquired for Central Park the lofty rock piles between 106th and 110th Streets; laid out the wide avenues of northern Manhattan, curving St. Nicholas Avenue to tie Central Park to Riverside Park; and developed approaches to the Harlem River bridges from the New York and Westchester side

From city planning to the creation of a greater Ne
York was a logical step. Nineteenth-century Ne
York was confined to Manhattan, but the populati
had already spilled out into what is now Brookly
Queens, Staten Island, and The Bronx—an area si
teen times the size of the city—and had clotted in
a hundred jurisdictions, many overlapping and
with different systems of taxation. (By coinciden
the metropolitan region surrounding the city tod
is also approximately sixteen times the city's siz
swollen now into 1,600 jurisdictions. Green's reaso
for unity in plan and development are as compelli
today as they were in his time.)

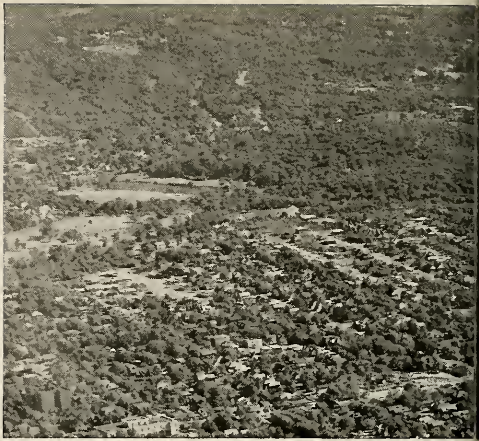
Through three long decades Green, the visiona
and the political engineer, gently but relentlessly wo
his noose around reluctant suburbanites. In 1898 "t
cities, towns and villages clustering about the Isla
of Manhattan, were united into one municipalit
under the historic title of the City of New York, a
this vast community replaced Paris as the second ci
of the world." Green was rewarded with a ceremo
at City Hall, a medal, and the title "The Father
Greater New York." At the age of 83, the old bachel
was shot by a disappointed suitor who, incredibly, mi
took him for a rival.

Since Green's time, government officials, planne
park commissioners, and private citizens have co
tinued to grapple with the persistent problems Gre
identified a hundred years ago, and which he remedi
with some success for his era. Recently, a proposal
build a highway across the so-called green belt (
connection with Andrew) of Staten Island has aga
raised questions about conservation, recreation, urb
development, and city organization. New York's cu
rent Parks Commissioner, August Heckscher,
quested Ian McHarg to take a look at the proble
McHarg is a peculiarly twentieth-century region
planner and landscape architect who believes, mo
fervently perhaps than even Andrew Green, that t
land itself has much to say to us about how it can a
should be developed. Here is what he says can
done about Staten Island.

Frances Lo



What would you do with, say, Staten Island?



In his Staten Island Study, Ian McHarg employs a method new in regional planning to map the social values inherent in the landscape of this beleaguered borough

Manhattan and its surround offer a magnificent site for a city. Values are abundant: the crystalline rocks of Manhattan at the surface, which offer magnificent foundations; a splendid, deep river and natural harbor; two bays at Jamaica and Newark; the noble Hudson (the paradisiacal river of the Indians, which flowed in two directions) draining a rich and beautiful hinterland; the ocean and beaches; marshes and meadows; palisades and ridges; and not least, a number of islands, among them Staten Island.

Given the powers of hindsight, it is clear that it would have been most advantageous if an evaluation of these resources had been made some hundreds of years ago and incorporated into a plan. In such a setting a great termitary could have been built upon Manhattan, whose inhabitants could have roamed to ocean and river, beach and bay, marsh and meadow, and to the many islands. But it was not to be, and inexorable growth spread a smear of low-grade urban tissue, expunging this great richness and value.

Had our hindsight been applied, Staten Island would have ranked high among the splendid resources for the city population. It is a special place—its geologic history has made it so. Silurian schists form the spine of the island, but the great Wisconsin glacier of Pleistocene time left its mark, for there lies the evidence of the terminal moraine. There are glacial lakes, ocean beaches, rivers, marshes, forests, old sand dunes, and even satellite islands. Among its treasures were beds of oysters and clams so extensive that the earliest inhabitants could not conceive that they could ever be consumed. Nor were they—like many other resources, they were rendered useless by pollution.

Staten Island retained its quality as a bucolic haven rather longer than any other area as near to Manhattan, but in the postwar period, speculative builders made it the testimony to their shortsightedness and greed. Yet all is not lost; even though the Verrazano-Narrows Bridge has opened the floodgates to urban development, some splendid residues still remain—the green belt and much of the southern part of the

Based on a chapter from Design With Nature.
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sland. Happily too, much of this land is owned by he City of New York and is administered by the Department of Parks. This client asked that a study be made of the island to discern its intrinsic suitabilities rom which conclusions could be made upon the use and disposition of the land.

This, then, is a problem of evaluation: which lands are intrinsically suitable for conservation, for active and for passive recreation; which are most suitable or commerce and industry; and which for residential and use? The basic proposition employed is that any place is the sum of historical, physical, and biological processes, that these are dynamic, and constitute social values, that each area has an intrinsic suitability for certain land uses, and finally, that certain areas lend hemselves to multiple, coexisting land uses.

The serpentine ridge and the diabase dike of Staten sland can only be comprehended in terms of historical geology. The superficial expression of the island is consequence of Pleistocene glaciation. The climatic processes over time have modified the geologic formations, which account for current physiography, drainage, and distribution of soils. Various associaions of plant species occupy the place, making it possible for a myriad of animal species to exist. Human occupation modifies the natural processes by ts own contribution.

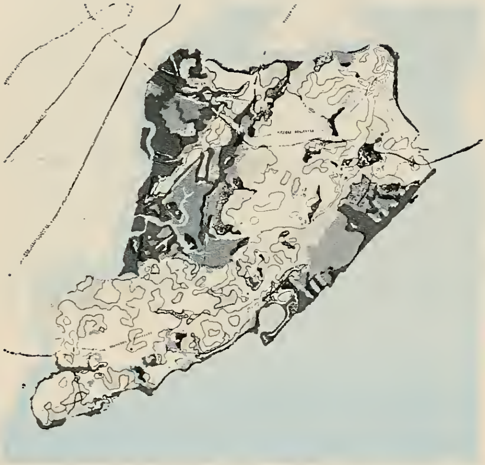
The island has come to be as a result of the dynamsm that is inherent in all natural process. But cycles of seasons and tides, the hydrological cycle, and the ecycling of vital nutrients are still going on. Hills rode and the sediments follow gravitational paths. Dunes form and create bays that fill over time. Hurricanes sweep up over oceans and bring tidal inundaion. It is important to recognize the dynamism of physical and biological processes and, more imporant, to recognize that these affect man and are afected by his intervention.

Land, air, and water resources are indispensable o life and thus constitute social values. The bayhores have a high value for recreational and residential development, but they also represent a negative value because of their susceptibility to tidal inundation. The surface waters are a resource for water supply, recreation, and disposal of effluents, but their positive value is easily abused by pollution. Water management, prevention of erosion, provision of habitat for wildlife, and a retreat for study and delight are several of the social values represented by forest land and then lost when a forest is allowed to succumb to advancing development.

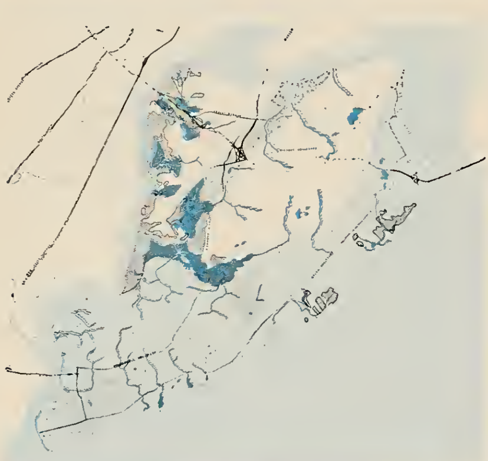
A recognition of these social values, inherent in natural processes, must precede prescription for the utilization of natural resources.

Once it has been accepted that the place is a sum of natural processes, and that these processes constitute social values, inferences can be drawn regarding utilization to ensure optimum use and enhancement of social values. This is its intrinsic suitability. For example, flat land with good surface and soil drainage is intrinsically the most suitable land for intensive recreation, while areas of diverse topography represent a higher value for passive recreation.

The social values represented by the natural processes are, more often than not, inherently suitable for a multiplicity of human uses. Flat, well-drained land is as suitable for intensive recreation as it is for commercial-industrial development. Areas of diversity and high scenic interest have a high social value for conservation and passive recreation, at the same time being highly desirable locations for residential development. These apparent conflicts can be resolved in a number of ways. Because of their scarcity and vulnerability, certain resources may represent such high value for conservation that other uses should be excluded. Multiple uses of some areas may be permitted if it is assured that intrinsic values are not compromised. In cases where two uses are coequally suitable, it remains with society to make the choice. The Staten Island Study, which follows, is not a plan. A plan includes the entire question of demand and the resolution of demand relative to supply, incorporating



HYDROLOGY



SOIL DRAINAGE ENVIRONMENTS

the capacity of the society or institution to realize i objectives. This study merely indicates those are where certain land uses, both single and multiple, c occur with the least costs and the greatest savings ar benefits.

But even at this stage it has innovative virtues th justify examination. The first of these is that it emplo rational method: the evidence is derived, in the mai from exact sciences. The statements made on t major data subjects—geology, hydrology, soils, pla ecology, and wildlife—are collected from substanti sources and are unlikely to contain major errors. Th holds true for the interpretations of zones of atmo pheric pollution, tidal inundation, rocks in terms compressive strength, soil drainage, and the rest.

In addition to being rational, the method is explic Any other person, accepting the method and the ev dence, is likely to reach the same conclusions as tho demonstrated in the study. This is in direct contra to the bulk of planning, where the criteria are oft obscure and covert. Moreover, this method permi a most important improvement in planning method that is, that the community can employ its own val system. Those areas, places, buildings, or spaces th it cherishes can be so identified and incorporated in the value system of the method. Today many plannir processes, notably highway planning, are unable incorporate the value system of the community to transected. At best, the planner supplies his own di tant judgment.

How does one proceed with this task? Well, we wi begin with the original proposition: nature is proce and value, exhibiting both opportunities and limit tions to human use. Therefore, we must identify th major physical and biological processes that cause Staten Island to be and that operate there now. W will not, in this case study, describe the content of th data. Many of these will be illustrated, but the expo sition will be limited to a description of the metho alone.

All basic data were compiled and mapped—climat historical geology, surficial geology, physiograph hydrology, soils, plant ecology, wildlife habitats, an land use. These data are of little use until they a interpreted and evaluated. For instance, general da on climate are of little significance, but those on hurr canes and the resultant inundation are vital, for wi them we can identify gradients of susceptibility inundation. The basic data are thus interpreted an reconstituted within a value system.

From each of the major data categories, a numbe of factors are selected and evaluated. From geolog we identify features of geologic, scientific, and educ tional value and grade them from unique to abundan rocks are evaluated for their compressive strength an ranked as foundation conditions; and so on, for ever category. For certain land uses the maximum cond tion will be preferable; for others, it will be the minimum that has the highest value. The least tidal inundation is to be preferred, but the highest scenic quality is the greatest value.

For each prospective land use there will be certain factors of greatest importance and these can be selected. Moreover, there will be a ranking of importance and so the factors can be arranged in a hierarchy. In addition, in some cases certain factors will be conducive to specific land uses while others are restrictive. In the selection of areas intrinsically suitable for conservation, the factors selected were: features of historic value, high-quality forests and marshes, bay beaches, streams, water-associated wildlife habitats, intertidal wildlife habitats, unique geologic and physiographic features, scenic land and water features, and scarce ecological associations. As an example of conducive and restrictive factors, selection of the most suitable areas for residential land use would include attractive surroundings, and so scenic land features, locations near water, and the presence of historic sites and buildings will be positive factors, while excessive slopes, poor drainage, and susceptibility to flooding will be negative factors.

More than thirty factors were considered, and they were subdivided in the categories of climate, geology, physiography, hydrology, soils, vegetation, wildlife habitats, and land use. Within each of these categories data were collected on factors of importance to all prospective land use. From the original sources—climate, geology, etc.—the factors of greatest importance were selected. In the general subject of climate the matter of air pollution was deemed important, as was tidal inundation from hurricanes. Within the category of geology, features of unique scientific value were identified and the major surface rock types were classed for compressive strength. Following the identification of the most important factors, each one was evaluated in a gradient of five values. For instance, serpentine and diabase constitute class one foundation conditions, while marsh and swamp occupy the lowest rank on the scale. All factors were so evaluated.

Each factor was mapped in tones of gray from most to least, and this same information was reversed to be employed in inverted order when necessary. All of the maps were made as transparencies. The group of relevant factors for each prospective land use was assembled and photographed. The results were then value gradients that incorporated all the appropriate factors. These maps showed the maximum occurrence of all the positive factors and the least restrictions.

Processes, reconstituted as values, indicated the areas intrinsically suitable for each of the land uses considered. As an example of the application of the method, the constituent values employed to reveal areas most suitable for recreation were mapped, in five divisions, with the darkest tone representing the highest value and the lowest value shown as blank. All these maps were made into transparent negatives, which were superimposed and photographed. The resulting photographs, shown on page 32, represented the summation of all of the values employed and were therefore indicative of the areas most to least intrinsically suitable for active and passive recreation. These two are then combined to arrive at the composite suitability for recreation shown on page 32. The salient factors selected for determining recreation areas are:

PASSIVE
Unique physiographic features
scenic water features
streams
features of historic value
high-quality marshes
scenic land features
scenic cultural features
unique geologic features
scarce ecological associations
water-associated wildlife habitats
field and forest wildlife habitats

ACTIVE
bay beaches
expanse of water for pleasure craft
freshwater areas
riparian lands
flat land
existing and potential recreation areas

Areas most suited for urbanization are determined separately for the two major components of urbanization: residential and commercial-industrial developments. For each of these the most permissive factors are identified. These are:

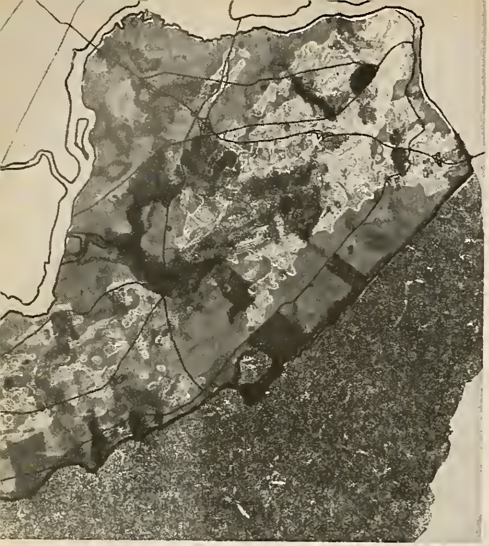
RESIDENTIAL
scenic land features
riparian lands
scenic cultural features
good bedrock foundations
good soil foundations

COMMERCIAL-INDUSTRIAL
good soil foundations
good bedrock foundations
navigable channels

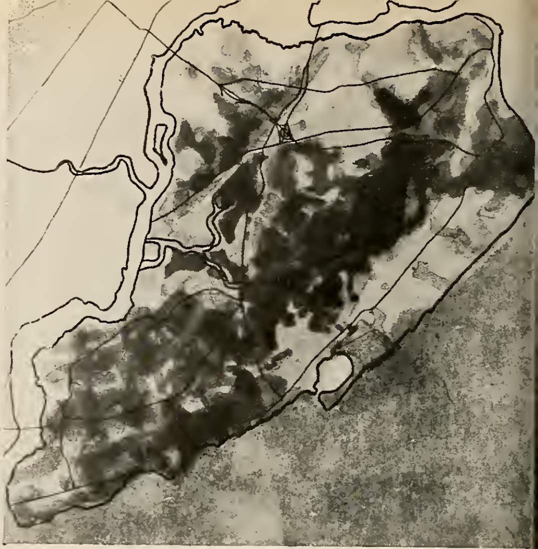
The most restrictive factors that are common to these developments are also identified:

slopes
forested areas
poor surface drainage
poor soil drainage
areas susceptible to erosion
areas subject to flooding

The composite suitability for urbanization is arrived at by combining these and is shown on page 33.

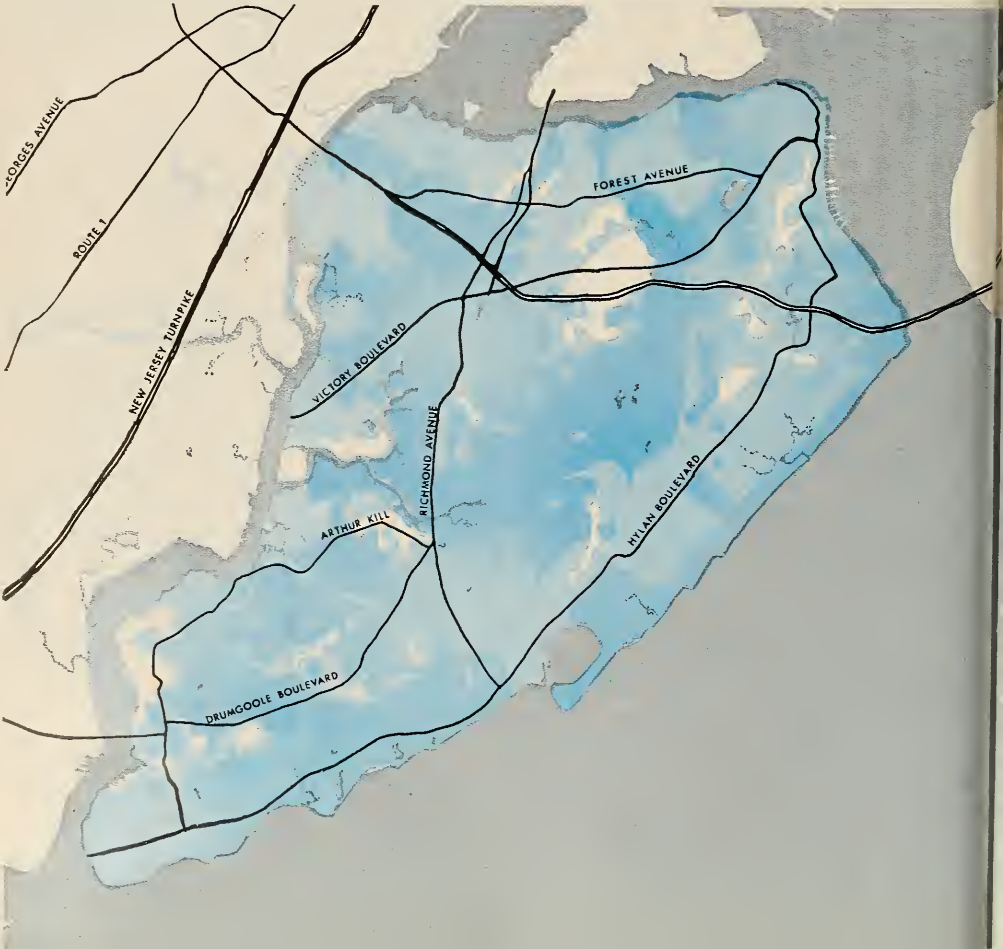


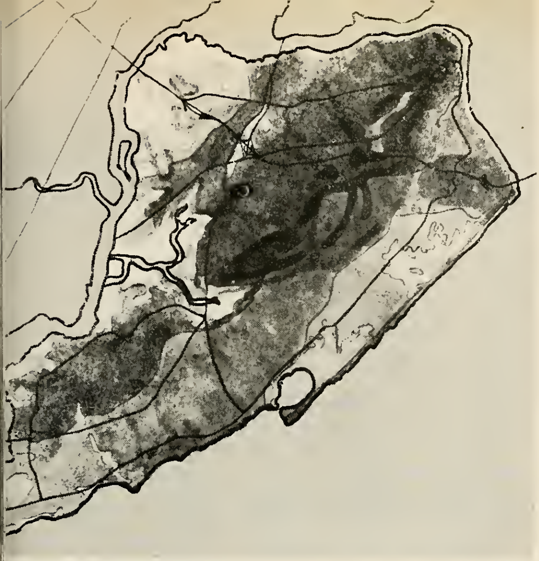
ACTIVE RECREATION SUITABILITY



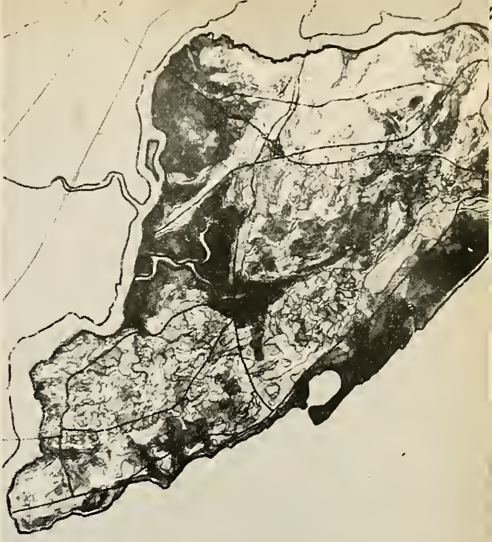
PASSIVE RECREATION SUITABIL

RECREATION SUITABILITY


EORGES AVENUE
ROUTE 1
NEW JERSEY TURNPIKE
FOREST AVENUE
VICTORY BOULEVARD
RICHMOND AVENUE
ARTHUR KILL
HYLAN BOULEVARD
DRUMGOOLE BOULEVARD

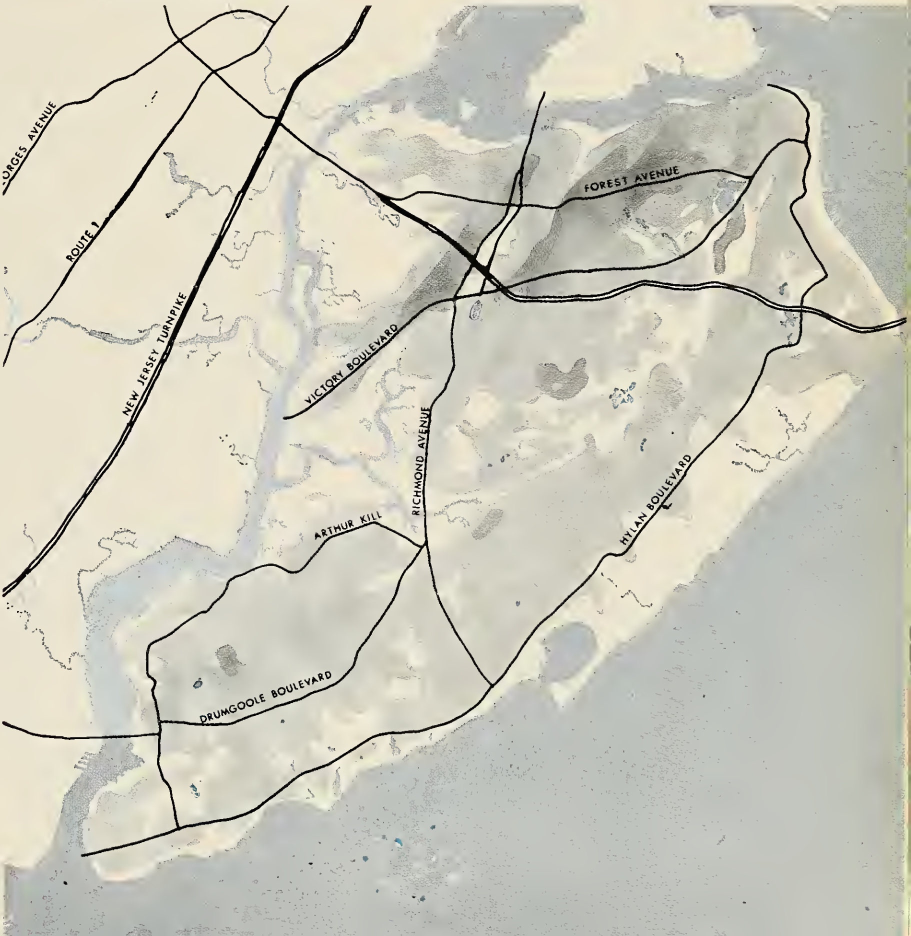


IDENTIAL SUITABILITY



UNSUITABILITY FOR URBANIZATION

URBANIZATION SUITABILITY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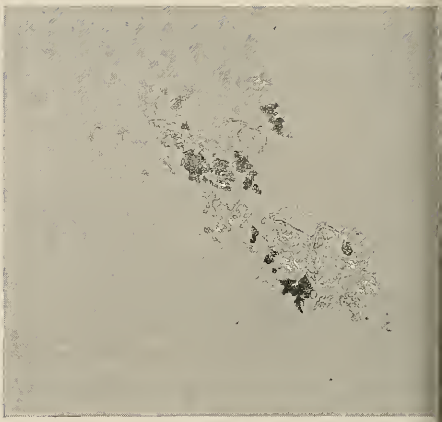


EXISTING FOREST QUALITY

The salient factors selected for conservation were:

- features of historic value
- high-quality forests
- high-quality marshes
- bay beaches
- streams
- water-associated wildlife habitats
- intertidal wildlife habitats
- unique geologic features
- unique physiographic features
- scenic land features
- scenic water features
- scarce ecological associations

All twelve factors were mapped in the manner shown here and photographed. The photographs were reconstituted into a single map, far right, with the values for conservation indicated in five values.

There are now maps of intrinsic suitability for residential land use, commerce-industry, conservation, passive and active recreation. These have an existence in their own right, but we seek to find not only intrinsic single uses but also compatible coexisting ones and areas of competition. We can then take complementary pairs and reduce them to single maps. Commerce-industry and residential use can be incorporated into a single map of urban suitability. Active and passive recreation can be combined into a single one of recreational suitability. We then have a residuum of three maps—conservation, recreation, and urbanization—which we are required to resolve. While the single suitabilities could be represented using tones of gray on transparent maps, this technique cannot avail us now. It is necessary to employ color. Let us allocate yellow to conservation and reconstitute the tones of gray into a range of brightness. We will map recreation in grades of blue and urbanization in gray. Where a land use has no conflict, nor is it complementary, we can map the area in its appropriate color and in a scale of brightness appropriate to its value. Where there are complementaries, such as recreation and conservation, the combination of blue and yellow will produce green, and the brightness will reflect the degree of value. The combination of gray and blue—urbanization and recreation—will show in the blue-gray range while a coequal suitability for all three categories will result in the combination of gray, blue, and yellow to produce a range of gray-greens.

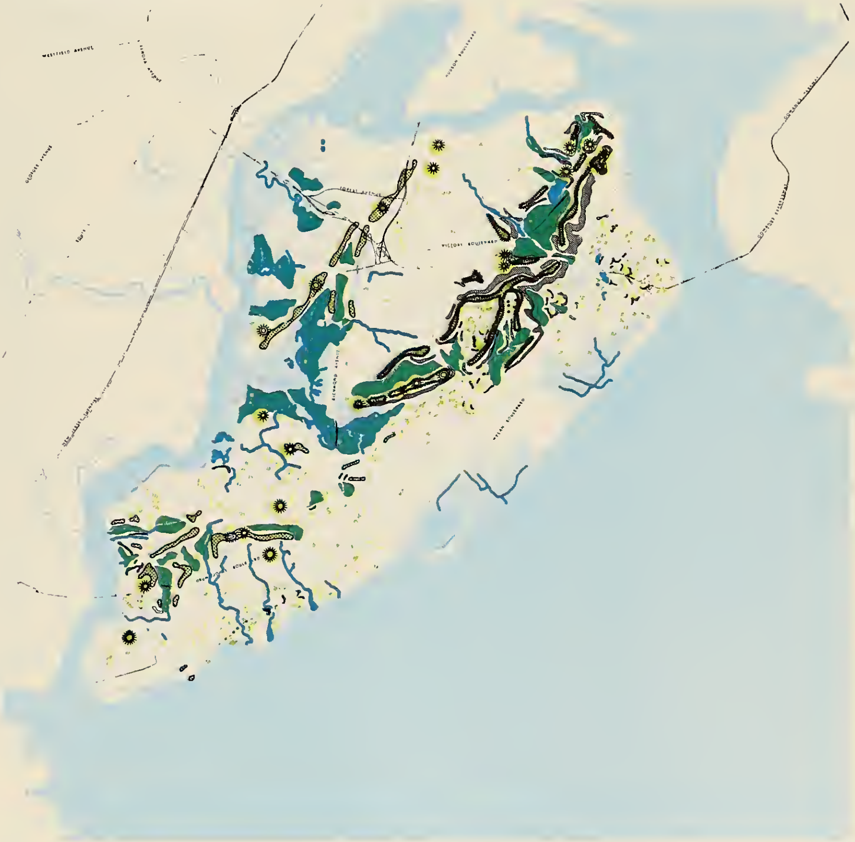
In the preparation of the final map it is impossible to resolve the suitabilities, compatibilities, and conflicts by superimposition and photography and so the preemptive method was used. This consisted of locating all primary suitabilities not in competition with any other primary values and mapping them, thus preempting the appropriate areas. This is continued with secondary and tertiary values until the summary map shows all unitary, complementary, and competing intrinsic land uses. Those shown as coequally suitable for more than one use may either compete or offer particular opportunities.

By abandoning absolute economic values, which cover only a small range of price values, and employing a relative system of most to least, it is possible to include all of the important factors that defy pricing by economists. While this denies an illusory precision of cost-benefit economics, it does show the relative concurrence of positive factors and their relative absence. Although we are unable to fix precise money values on these, it is safe to assume that, in the absence of any supervening value, the concurrence of the majority of positive factors in any one location does indicate its intrinsic suitability for the land use in question.

CONSERVATION SUITABILITY

SCENIC VALUE (Land)

HISTORIC FEATURES VALUE


WESTFIELD AVENUE
HUDSON BOULEVARD
VICTORY BOULEVARD
RICHMOND AVENUE
HYLAN BOULEVARD

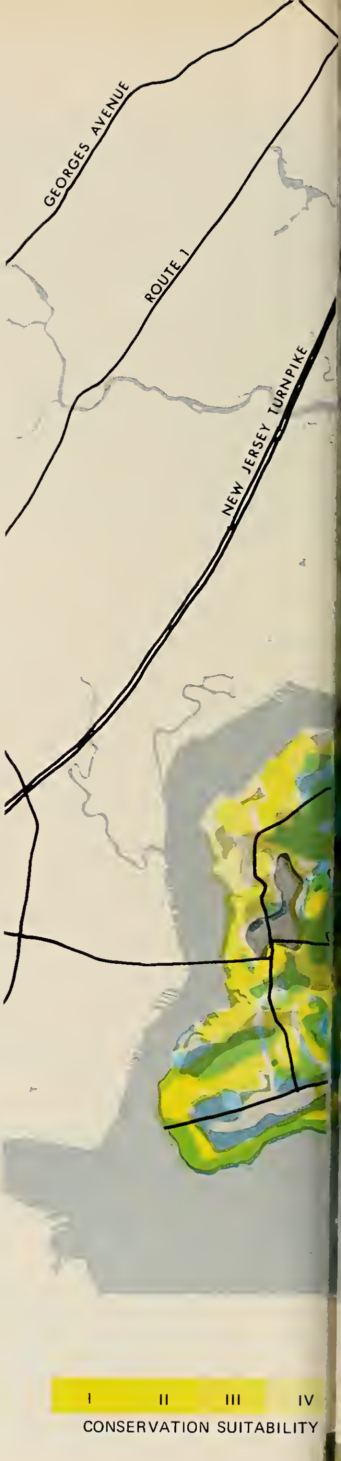
Another value is that the information so compiled and interpreted constitutes the base data required to subject any planning proposal to the test of least cost —maximum benefit. The values of the area in question for the major land uses have been identified, and the degree to which any proposal will destroy or enhance these can be demonstrated. Moreover, these same data simplify the quest for least-social-cost locations. By making explicit the factors employed, it is possible for society at large and for individuals to insist that the development process, both public and private, respond to these values. It would serve a most useful purpose if maps of the value of an area, and the intrinsic suitabilities, were made public so that developers could know where they planned to tread and, more positively, could be led to areas intrinsically suitable for their energies.

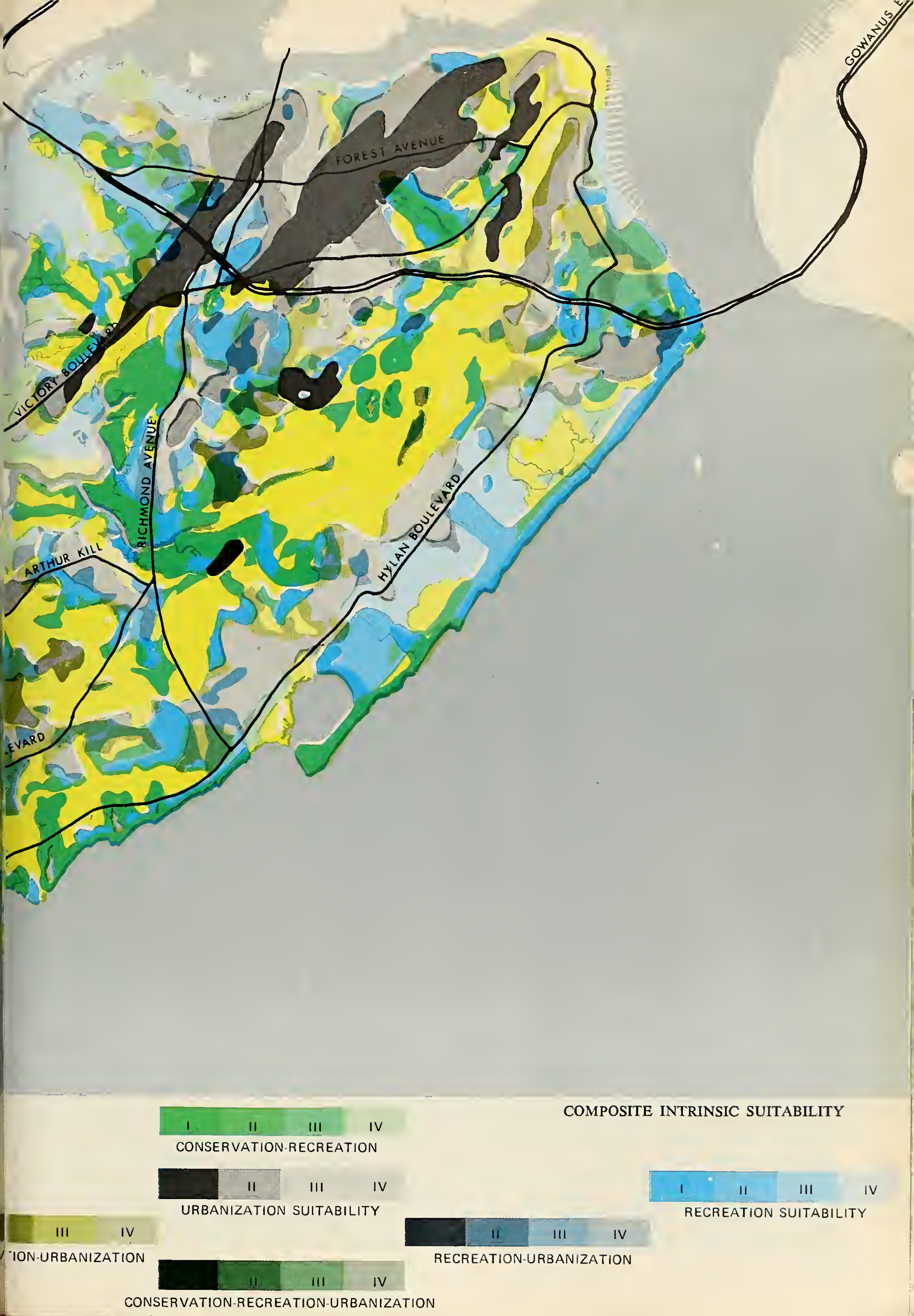
Perhaps one of the most valuable innovations of the method is the conception of complementary land uses, the search for areas that can support more than one use. This tends to conflict with the principle of zoning, which enforces segregation of land uses. The recognition that certain areas are intrinsically suitable for several land uses can be seen either as a conflict or as the opportunity to combine uses in a way that is socially desirable. In many of the older European cities that are so extravagantly admired there is a perfectly acceptable combination of residence and shopping and even certain manufacturing. It is possible to combine land uses but this requires some discretion and even art.

Normally, land-use maps, and even planning proposals, show broad categories of uses. The maps in this study are more like mosaics than posters—for good reason. They result from asking the land to display discrete attributes that, when superimposed, reveal great complexity. But this is the real complexity of opportunity and constraint. It may appear anarchic, but only because we have become accumstomed to the dreary consistency of zoning, because we are unused to perceiving the real variabilities in the environment, and responding to them in our plans.

Certain technical problems are inherent in the method. The first of these is to insure parity of factors. The results will be qualified if the factors are of disproportionate weights. Too, there are limits to the photographic resolution of many factors and this study reached that threshold. The mechanical problem of transforming tones of gray into color of equal value is a difficult one, as is their combination. It may be that the computer will resolve this problem, although the state of the art is not yet at this level of competence.

Such is the Staten Island Study. It is one of the most elaborate that the author has undertaken, and it does offer some hope for a planning process that is rational, explicit, replicate, and can employ the values of the community in its development.




GOWANUS E
FOREST AVENUE
VICTORY BOULEVARD
RICHMOND AVENUE
ARTHUR KILL
HYLAN BOULEVARD
EVARD
I
II
III
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CONSERVATION-RECREATION
II
III
IV
URBANIZATION SUITABILITY
I
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RECREATION-URBANIZATION
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CONSERVATION-RECREATION-URBANIZATION

COMPOSITE INTRINSIC SUITABILITY

Dinosaur-like caterpillar of the four-horned sphinx moth.

Indigens and Immigrants

by Alexander B. Klots

The constant stream of incoming populations to New York has not been restricted to humans; many plants and animals have also become naturalized citizens. Hordes of imported and native insects, for example, have found life generally congenial in the metropolitan area, although their numbers and distribution have fluctuated with natural and man-made environmental changes.

Enormously more diverse and numerous than any other land animals, insects flourish in nearly every possible land and freshwater environment. While some of them are adaptable to change, the majority are so specialized for life in narrow ecological niches that they may be drastically affected by even apparently slight shifts of their environment. We can understand the insects of a region only in terms of the past and present environments; conversely we can learn much from the insects that will enable us to understand the environment. This is especially true of the New York City region, which during the last 10,000 years has undergone a major climatic reversal, to which have been added extreme man-made changes compressed into about the last 350 years.

Red mites hitchhike on Mansonia *mosquito, right, a viciously biting pond species. Caterpillar hunter beetle, below, climbs trees in search of its prey. Far right: a beetle,* Cyllene robiniae, *feeds on locust trees and mimics black-and-yellow wasps for protection. Below center: caterpillar of tussock moth feeds successfully on most city shade trees.*

Taking warning from the biographer of St. George, who thought he should begin with the birth of the dragon, we will look back only to the end of the Pleistocene, the last great ice age. About 10,000 years ago the southern edge of the last great continental glacier, the Wisconsin, dumped its final terminal moraine on Staten and Long Islands, finished scratching and scouring the exposed rocks of Central Park, and began its final northward recession.

Promptly, all across the continent, the plants and animals that had been forced southward by the cold and the approaching ice began moving northward to repopulate the ice-free areas. In only about 4,000 years, when the climate reached a warm peak, the continent was again fully occupied by life, with many warm-climate species extending farther northward than they do today. A short period of increasing cold forced many of these southward again, but another warm-up followed, which is still continuing; again, many species are extending their ranges northward. In this latest, but probably not the last, of the many climatic fluctuations since the Pleistocene, most of eastern North America became a region of dense forests: the evergreen Canadian forest northward, and the great temperate deciduous forest southward from northern New England and New York. The forests are the climax plant formation, the type of plant cover that, if undisturbed by man or other calamities, will occupy most of the area and maintain itself against competitors.

Because of its topography, however, the New York region has always been markedly diversified, with many areas where the climax forest is broken and lesser plant formations can exist. The Hudson River and smaller streams flowing into the great, landlocked harbor; the barrier strips of beach; the salt marshes; the rocky escarpments that often reach the water's edge; the ponds and freshwater marshes; all have acted to break the monopoly of the forest in a multiplicity of ways. Inland, stands of hemlock, white pine, and red cedar grew on cold hillsides or in special soils. In both New Jersey and on Long Island dense groves of white

cedar filled the acid swamps; and in drier, sandy areas extensive, open barrens were covered with heaths, scrubby oaks, and pitch pines. Everywhere were grassy meadows where some disturbance had broken the forest cover. The older meadows showed many successional stages of domination by grasses and sedges, herbaceous plants, shrubs, and quick-growing trees, which eventually would be shaded out by the climax forest. There were many ponds and lakes and marshes, often where beaver had cut and flooded valley forests. This greater diversity of plants, in turn, meant an enormously compounded diversity of insects and of other animals dependent on them.

Extending down from the north, the high and therefore colder ridge of the Taconics connects the Green, White, and Berkshire mountains with the lower Hudson Valley at Anthony's Nose, Bear Mountain, and Storm King. Along this ridge and in the nearby Catskill Mountains many cooler-environment plants and animals survive, their populations constantly replenished by the northward connection. Paradoxically, in some of these Hudson Highlands are colonies of warmer-climate plants and animals, such as the prickly-pear cactus and the little fence lizard. Ordinarily inhabitants of the warmer coastal plain, these survive on large, bare rock slopes, as on Mount Taurus near Cold Spring, New York, that face southward and westward catching the sun's heat.

The Atlantic coastal plain sweeps up from the southern tip of Florida to New Jersey and Long Island, low, flat, and warm and unbroken except by rivers. Many times it has served as the northward migration route for southern plants and animals during periods of climatic warming; and in it the southern forms can exist much farther north than in the hilly and mountainous country inland. Lying practically at the northern terminus of the coastal plain, the New York region has many southern plants and animals mixed among more northern ones, especially in New Jersey, Long Island, and Staten Island. Along the railroad track south of Lakehurst, New Jersey, many little bog copper butterflies (*Lycaena epixanthe*) fly over a cranberry bog only a few feet from where the Georgia satyr (*Euptychia areolata*) flies in and among sedge tussocks. The copper ranges from here northward to Labrador and Manitoba, while the range of the satyr extends southward to Cape Sable, Florida. Consisting of a relatively small variety of plants, the climax forest supports correspondingly few different insects. Nor is it as productive of food for animals or humans as its rich appearance might lead one to believe. For humans, in particular, the forest is especially unproductive. Agricultural man has always been forced either to live in naturally unforested areas, to destroy the forest, or to live around its fringes. To some degree the eastern woodland Indians followed a practice of clearing the forest, but essentially they left the forest undisturbed and lived in scattered villages where there was natural open land available. It has been claimed that the beaver destroyed more trees than Indians did.

One such village, contemporaneously described as nestling among trees at the water's edge, was on the southern tip of Manhattan Island. An old Indian tradition claims that Henry Hudson landed here in 1609, tapped a keg of spirits and staged the island's first wild party, and that the Indian name "Manhattannik" means "the place where we were all drunk." At any rate, European settlement began on the island in 1615, although the date is sometimes given as 1626 when Peter Minuit purchased the 22,000 acres of Manhattan from the Indians for merchandise valued at 60 guilders (about $24). Other settlements followed, and European man went to work eliminating the beaver, the Indians, and the forest.

The growth of the original settlement at the tip of Manhattan was relatively slow. In 1678 (after the English had taken over) a bear was killed in John Robinson's orchard, apparently along Pearl Street north of Pine Street. The population of the city was then probably about 2,000. The other towns that sprang up in the

Nonmelanic pepper-and-salt moth rests inconspicuously on light bark, above. Left: Karner blue butterfly may have been a former Manhattan resident. Below: the milkweed beetle's bright color signals "nonedible" to birds.

area were for long located only where waterborne transport was possible. But far ahead of urban expansion went agriculture, and of course this meant getting rid of the forest as quickly as possible by girdling and burning the trees. Such "girdling" was, in fact, specified in land grants. Somewhat later, enormous areas of forest were cut for making charcoal, then essential for iron smelting. Inevitably the forest insects and other animals were greatly reduced in numbers, although most of them, such as the walking sticks (*Diapheromera femorata*) and the grotesque acorn weevils (*Curculio*), have managed to survive. Insects are favored by their small size, for quite a large population of a species may develop year after year in only one or two trees of the right kind. Most successful were the general tree-feeding species that were able to switch to almost any tree, even to imported ones or man-made hybrids. For instance, everywhere in the city today we find the white-marked tussock moth (*Notolophus leucostigma*). I have counted over a hundred cocoons on a single red maple, and in 1957 hundreds of caterpillars, reared on the hybrid plane trees in Bryant Park, were seen crawling all over the Public Library and the sidewalks. The evergreen bagworm (*Thyridopteryx ephemeraeformis*) is another general tree feeder that has survived in very large numbers. Right now its cocoon-like larval cases are dangling from the trees around The American Museum, full of eggs about to hatch. Both of these successfully urban-adapted moths have wingless females, which poses the question of how they spread from tree to tree along even the busiest city street. Another successfully surviving tree insect is the large caterpillar-hunting beetle, *Calosoma scrutator*, adept at climbing high in trees in search of its prey. Its congener, the brighter green European *C. sycophanta,* introduced from Europe to help control the gypsy moth, has not done as well, but small populations survive.

As the climax forest was cut, the quick-growing "succession trees" such as wild cherry. sassafras, poplars, and black locust were given an unprecedented opportunity and increased many thousandfold around the edges of woodlots and in pastures and hedgerows. Correspondingly, insects specializing on such trees increased greatly. It is possible to see a great many promethea moth (*Callo-*

samia promethea) cocoons hanging from twigs in the city parks in winter. And the weird caterpillars of the spicebush swallowtail (*Papilio troilus*) can often be found, especially on sassafras. This tree, incidentally, took a bad beating from man in early colonial times, since its fragrant bark and roots were considered very valuable medicinally, particularly for treating venereal diseases, and were sent to Europe by the shipload. The large pink underwing moth (*Catocala concumbens*) certainly benefited greatly from the inevitable increase of poplars and aspens, trees especially quick to occupy the site of a burned forest. As the common black locust tree has proliferated greatly, so have many of its special insects. The locust borer (*Cyllene robiniae*), a large long-horned beetle that mimics black and yellow striped hornets, can be found in autumn in great numbers about these trees, most commonly visiting goldenrod flowers. And perhaps the best-known of the succession tree feeders is the tent caterpillar (*Malacosoma americana*) whose silk nests can be seen almost everywhere in the spring, especially on wild cherry. Many hundreds of similar examples could be cited.

Clearing the forest meant even greater benefit for the thousands of insects that feed on the great variety of herbaceous plants, grasses, and sedges that spring up immediately wherever there is an opening. I have no doubt that we have many times more numerous populations of such insects in our area then were here in pre-Columbian days: and this includes most of the familiar insects of our meadows, roadsides, and waste grounds. One of the most familiar is the honeybee, a European import from early colonial days, but the majority are *nouveau riche* natives.

We may have lost most of the delicate West Virginia white (*Pieris virginiensis*), a butterfly of cool deciduous forests where it feeds on toothwort on the forest floor, but we have seen a great increase in numbers of the checkered white (*P. protodice*), whose larvae feed on a number of cresses in dry, weedy waste places. And, of course, we have gained millions of the European cabbage butterfly (*P. rapae*). A few years ago I heard of caterpillars of this species damaging nasturtium plants in a midtown Manhattan penthouse garden many stories up. The total populations of some of the tree-feeding hairstreak (*Strymon*) and anglewing (*Polygonia*) butterflies have declined: but the dainty eastern tailed blue (*Everes comyntas*), which feeds on bush clovers and other plants of dry fields and waste places, is still common. The great host of insects feeding on the milkweeds, such as the milkweed leaf beetle (*Labidomera clivicollis*) and the famous monarch butterfly (*Danaus plexippus*), benefit by the abundance with which these plants spring up everywhere in mixed meadows and waste places. I have seen hundreds of monarch larvae in Van Cortlandt Park and along Bruckner Boulevard and in the Hunts Point region of the Bronx. Adult monarchs on their southward migration abound in autumn, and are often seen sailing through the smog among the skyscrapers.

One lovely little butterfly has always intrigued me because of an old hearsay record that a colony once existed near Dyckman Street. This is the Karner blue (*Lycaeides melissa samuelis*), whose nearest colony is now near Albany in a pine-barren area where its food plant, lupine, abounds. Incidentally, it was given its scientific name by Vladimir Nabokov, whom most people know as one of our great novelists rather than as a student of butterflies.

Besides poisoning the environment and polluting the atmosphere, the airborne wastes that descend on our area have had some very interesting side effects. Many owlet moths (*Noctuidae*) and measuring-worm moths (*Geometridae*) regularly rest during daytime on tree trunks, where their gray and brown colors and patterns camouflage them to the birds that prey on them. Now, however, the tree trunks in industrial areas have become dark and grimy like everything else, and have lost the bright, variegated lichens that formerly grew abundantly upon them. In a remarkably fast evolutionary response to the darkened environment many species of the moths have developed blackish colorations that keep them inconspicuous. Much research on this striking evolutionary change, called "industrial melanism," has been done in England, especially around London, Birmingham, and other industrial centers; but very little work has been done on American moths, although we can see that many are becoming melanic. What better place than New York for such research?

What has happened and is happening to our native plants and animals is only a part of the story. From the very earliest days foreign plants and animals have been imported, originally mostly from Europe. A monograph by a Swedish entomologist, C. L. Lindroth, traces in detail the effects of bringing soil as ballast in ships and unloading it over here. (Some downtown New York City streets are still paved with stones brought as ballast.) Laws required that the ballast be unloaded on land, to prevent filling up harbors. Many soil-living animals were thus imported, especially some of the ground beetles (Carabidae), which thus became naturalized and spread inland from the seaports. Dr. Willis Gertsch of The American Museum has similarly traced the dispersal patterns, from seaports, of introduced spiders. Of all such things New York has received its full share. The Hessian fly (*Phytophaga destructor*), our most serious wheat pest, is supposed to have been brought to New York in their straw bedding by Hessian troops during the Revolutionary War. When it got into the upstate New York wheatfields, the granary of the Revolution, it did more damage than the Hessians. In recent times, the European corn-borer (*Pyrausta nubilalis*) and the Japanese beetle (*Popillia japonica*) are only two of scores of destructive foreign insects that have been imported —and more keep coming.

The colonists brought over both food and ornamental plants in great numbers, with no thought of the insects that accompanied them. With the apple came the codling moth (*Laspeyresia pomonella*), now the most destructive apple pest all over the continent. More recently has come the enormous European hornet (*Vespa crabro*), which invades our attics and gnaws the bark of our lilacs (also imported). Many of the imports came over so early and have been so successful that most people take for granted that they have always been here. The daisies and Queen Anne's lace (wild carrot) of our fields, the dandelions of our lawns, and most of the grasses of our parkways are all imports. Sometimes native insects like the black swallowtail (*Papilio polyxenes*), which thrives on wild and tame carrots and parsley, take to the foreign plants.

Due to extensive planting the shade trees of the city are becoming more and more foreign, since the oriental ginkgo and the hybrid plane tree seem to be best able to survive street life, traffic fumes, and fallout. Most abundant is the Chinese tree of heaven (*Ailanthus*) that plants itself everywhere—in parks, vacant lots, backyards, railroad tracksides, and waste places. Along with it was imported the very large saturniid cynthia moth (*Philosamia walkeri*), which has been equally successful in the city, despite the work of many native parasitic wasps. As a boy I collected hundreds of its cocoons in Central Park; and only a few years ago I picked up dozens under the big ailanthus that shades the Alexander Hamilton mansion on Convent Avenue. Although the tree has spread all over the northeast, the moth seems to be unable to maintain itself outside of the large cities. Perhaps it is very temperature-sensitive, or perhaps it *likes* leaves covered with soot.

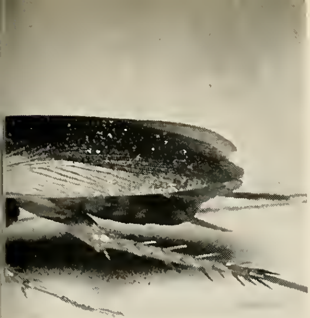
A most interesting area in Pelham Bay Park near City Island exemplifies much of what has happened in the New York area. This was a site of very early settlement, for Anne Hutchinson was killed by Indians only a mile or so away in 1643. An extensive woodland consists almost entirely of European alder, European white poplar, and American black locust. This American tree has spread abundantly over much of Europe, so that this woodland could be duplicated in many places over there. The American elms have died, killed by the Dutch elm disease that is carried by both imported European and native American bark beetles, but there are quite a few European maples lining an ancient driveway. Under debris and among the abundant empty beer cans, the recently arrived European earwig (*Forficula auricularia*) is now common. In the adjacent meadow the Chinese praying mantids (*Paratenodera sinensis* and *angustipennis*) form their distinctive egg masses on weed stalks and twigs (most people will be surprised to learn that we have no native mantids north of Virginia) and the European bedeguar galls (*Rhodites rosae*) abound on the brambles. The field crickets (*Gryllus*) are native Americans, but the nearby houses of the Bronx, Pelham, and New Rochelle are full of the European house cricket (*Gryllus domesticus*), often chirping all winter, with or without hearths. A nearby baseball diamond (not a good cricket field) is mostly composed of imported grasses, including "Kentucky" bluegrass (a native Eurasian) and crabgrass (European), and populated by great numbers of sod webworms (native) and Japanese and Asiatic beetle larvae.

The enormous areas of marshland in our area have probably been devastated more than any other environment by pollution, fire, draining, and filling. Gone is most of their abundant bird life (The American Museum habitat group of the birds of the Hackensack Marshes shows us what we have lost) and practically all of their rich fauna of dragonflies, caddisflies, mayflies, and insects of many other groups that fed on marshland plants. Ten years or so ago I watched a big libellulid dragonfly, that certainly had not been reared in the area, hawking flies around a hotdog cart on Vesey Street. Nowadays I would not know where to look for a colony of the Baltimore checkerspot (*Euphydryas phaeton*), which feeds on turtlehead in wet meadows and around marshes. The last stand in our area of the broad-winged skipper (*Poanes viator*), a widespread marsh butterfly was in the marshes near Secaucus, New Jersey, at Snake Hill. This high mass of traprock, cut by the New Jersey Turnpike, has now been almost entirely leveled. It is reputed to have been the last refuge of the timber rattlesnake in the area. Much of what marshland remains may look superficially intact, but is mostly tall *Phragmites* reed, a disastrous substitute for the cattails that supported hundreds of different species from muskrats to the tiny pyralid moths that fed in its seed heads.

Top: Periplaneta americar
family was old, says Don Marq
archy the cockroach, "when n
was only a burbling whatis
A "rain barrel" mosquito
at right, so gorged with
author's blood that it cannot
Bottom: grotesque Curcu
weevil employs its beak to b
holes in acorns, in whic
then lays eg

But the story of our marshes is not all sad. Many early writers commented on the dense clouds of mosquitoes that swarmed in the marshes and often were blown into the towns by the millions. The chief offenders were the salt marsh species, *Aedes taeniorhynchus* and *sollicitans*, which all New Yorkers (with some injustice) united in calling "Jersey mosquitoes." Homegrown species such as the rain-barrel mosquito (*Culex pipiens*) were also abundant. We are glad that their numbers are greatly lessened, but deplore what the draining and spraying has cost us in other wildlife. We are also glad that malaria and its carrier, *Anopheles quadrimaculatus*, once common in our region, are no longer with us. As recently as the turn of the century, my father, while an interne at the Metropolitan Hospital on Blackwells Island, now Welfare Island, treated many cases of malaria, and studied the transmission of this disease by local *Anopheles* shortly after Walter Reed's discoveries in Cuba.

Even closer to home are the insects that are thoroughly domesticated in



even the most urban areas. Very possibly the bedbug (*Cimex lectularus*), housefly (*Musca domestica*), and oriental and German roaches (*Blatta orientalis* and *Blattella germanica*), the last widely known as the Croton bug, came over with the first shiploads of traders and settlers. We have native roaches as well, such as the large American roach (*Periplaneta americana*). Late one summer night the writer watched one of these roaches run out from a basement grating of a prominent university club on Vanderbilt Avenue, seize a bit of bread left for the pigeons, and scuttle back into its academic retreat. Recently a tropical roach (*Supella supellectilium*), which came from East Africa by way of Cuba and Florida, has become very common in the city. Living in the warm shelters of television sets, it feeds on insulation. This spirit has kept roaches thriving since the Carboniferous.

We have seen that in our area the once dominant, native forest insects have greatly diminished, but there is little evidence that many of them have been exterminated. While the marshland and freshwater insects have suffered the greatest reduction, most of the insects of grasslands, wasteplaces, mixed fields, meadows, parks, and forest successional stages increased enormously at first as the forest was cleared for agriculture. But they are now declining, most in heavily built-over areas, less in the suburbs and countryside. A few native insects and a considerable number of introduced ones thrive, some in even the most urban areas.

Because of the introduction and success of a great many exotic plants and animals, there is abundant evidence that the New York City area is becoming cosmopolitan in a broad, biological sense, not just in human terms. In this it resembles the rest of the great superurban community that is developing from Virginia to Maine. A new sort of superbiome, a North Temperate superurban life form, is developing. More and more Hamburg and Rotterdam, London and Le Havre, New York and Newport News are becoming biologically alike. Only by considering this, against the background of the past, can we possibly visualize the future life of our area.

SKY REPORTER

RIVERS ON THE MOON Even after the first astronauts (or cosmonauts) land on the moon, questions will outnumber answers about many lunar features for years, perhaps generations. In the meantime, while some lucky experimenters squeeze every last drop of information from samples returned to earth, the rest of us have the satellite photographs as our raw material.

Among the most tantalizing features on the Orbiter pictures are those that look exactly like terrestrial riverbeds. They begin on high ground, wander along paths complete with oxbows, and even circle around hills. Some can be followed easily for 500 miles. They do not look at all like lava flows or channels of volcanic ash; they look just like rivers.

Lunar material almost certainly contains water as a constituent of a number of minerals. It has even been proposed that future lunar colonies can process these minerals easily enough to supply their water needs. The question, in accounting for riverbeds, is how the water got to the surface and then failed to evaporate immediately into space.

Three scientists at UCLA offer an answer in a recent issue of *Nature*. Impact of a large object, particularly a comet, on the moon's surface would raise the temperature of the substrate enough to release water and gases from the minerals. As the first water rose toward the surface, it would encounter subzero temperatures and freeze into a layer of permafrost. As more water followed, it would move along under the permafrost layer, through fractures created by the impact, toward higher ground as it tried to rise. There it would be trapped under its protective blanket.

Finally, the permafrost might be cracked (by another impact or volcanic activity) and the trapped water would gush out along the surface, carving out a riverbed. This explanation may not sound very probable, but the moon has been there a long time. And the riverbed-like features are there.

NEW ERA FOR PULSARS After nearly a year of frustration and false alarms, optical astronomers have identified a visual object with a pulsar. A three-man team at Steward Observatory in Arizona found that the star at the center of the Crab Nebula is blinking at exactly the same 30 times a second as the pulsar found there last year.

There seems little doubt that the star is the core left by the supernova of 1054. Superimposed on its spectrum are emission lines from the shell of hot gases still expanding 900 years after the explosion. The star was not unknown: it was tentatively identified as the supernova core in a paper published in 1942.

The optical search since pulsars were first announced in early 1968 has proved unexpectedly difficult. At least two groups excitedly reported optical identifications last May, only to find later they had been misled by their instruments.

The Steward identification seems safe enough, however. Within days, colleagues at Kitt Peak in Arizona and McDonald Observatory in Texas confirmed the optical pulse. The discovery gives added weight to the hypothesis that the pulsars, probably neutron stars, are the end result of supernova explosions.

DIAMONDS IN THE SKY The sky may be full of more diamonds than the children's song ever anticipated. The stars are not the diamonds, however; the gems are to be found within the so-called empty space between the stars.

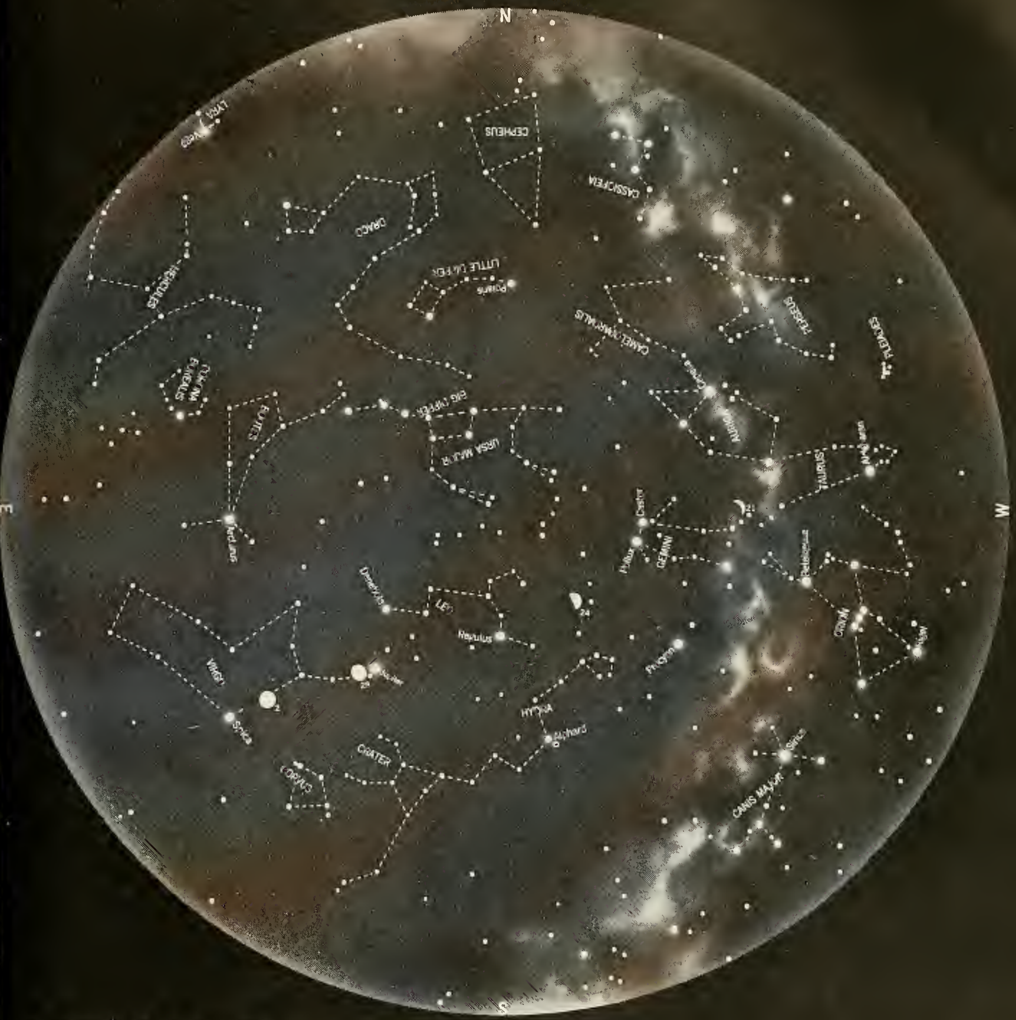
Astronomers have known for a generation that space is not empty; the light from distant stars is reddened and even twisted by vast clouds of dust. The clouds can be seen as dark lanes in the Milky Way and in nebulae. But the identity of the dust particles remains open to question.

Carbon in the form of graphite has long been a candidate. Others are ice crystals or ice-covered graphite grains. Neither seemed to account perfectly, however, for the effects the dust grains have on starlight. Now William C. Saslaw and John E. Gaustad of the University of California at Berkeley, writing in the British journal *Nature*, propose that diamonds may be the best answer advanced yet.

Saslaw and Gaustad argue that diamonds can best account for the absorption of starlight at the wavelengths actually observed. They point out that dust clouds are known to exist in very hot regions of ionized hydrogen, where diamonds would be better able to survive the extreme conditions than would more volatile substances.

Diamonds have been found in meteorites. One explanation has been that they were formed at high pressures in the interior of some primeval planet that later disintegrated. Saslaw and Gaustad question this explanation because other minerals normally formed under the same pressure conditions are not found in meteorites. They prefer to think of the meteoritic diamonds as part of the primordial material of the solar system. Meteoriticists, on the other hand, prefer to think that diamond grains found in meteorites were most likely formed as a by-product of an explosive impact with earth.

If they exist, the diamonds are not the size for engagement rings. Nevertheless, who can resist the attraction of clouds of diamonds, millions of miles across, floating around through space? JOHN P. WILEY, JR.


N
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Polaris
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PERSEUS
TRIANGULUM
CORONA BOREALIS
BOOTES
BIG DIPPER
URSA MAJOR
Capella
AURIGA
TAURUS
Aldebaran
Arcturus
Castor
Pollux
GEMINI
Betelgeuse
ORION
Rigel
Denebola
LEO
Regulus
24
VIRGO
Jupiter
28
2
Spica
Procyon
HYDRA
Alphard
CRATER
CORVUS
Sirius
CANIS MAJOR

CELESTIAL EVENTS

Full moon occurs on April 2; last-quarter on the 9th; and new moon on the 16th. The moon will be in the evening sky for the latter part of the month, with first-quarter on April 24.

Jupiter dominates the evening sky in April. Well up in the east at sunset, it remains visible among the stars of Virgo until it sets in the early morning.

April 1: Jupiter is to the west (right) of the nearly full moon, separating from it during the night.

April 6: Mars rises just before the moon tonight and appears above and to the right of the moon as both move up the eastern sky.

April 8: Both Venus and Mercury are in conjunction with the sun today, Venus at inferior conjunction (passing between the sun and earth) and Mercury at superior conjunction (on the far side of the sun). Venus now enters the morning sky, Mercury the evening sky.

April 18: Saturn is in conjunction with the sun and enters the morning sky.

April 22: The Lyrid meteor shower reaches maximum today. This is a weak annual shower, with an average of about 15 meteors per hour visible for the single observer. There will be no moon during morning hours.

April 26: Mars is stationary in right ascension. Its retrograde motion will take it closer to the star Antares, similar in brightness and color to the planet.

April 27: Venus becomes stationary in right ascension and begins to move eastward (direct motion). The planet should be visible low in the east just before sunrise.

April 28: Jupiter, after dark, appears to the right and above the nearly full moon.

April 30: The bright star near the moon is Spica.

THOMAS D. NICHOLSON

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 9:20 P.M. on April 1; 8:25 P.M. on the 15th; and 7:25 P.M. on the 30th; but it may be used for about an hour before and after those times.

GOTHAM'S BIRDS

by Dean Amadon

On a lovely May morning in Central Park, following a night of mild southerly winds and an occasional light shower, one can find the trees and shrubbery alive with birds. By 10:00 A.M., when the birds have become a little less active. their songs less continuous, bird watchers have recorded almost twenty species of warblers and many other migrants—vireos, flycatchers, tanagers, Rose-breasted Grosbeaks, and Olive-backed Thrushes. Of species such as the Chestnut-sided Warbler, which have increased with the clearing of the land, an observer may see more in a single morning than Audubon managed to see in a lifetime. Although bird watchers have been scrutinizing the park for at least seventy-five years, occasionally migrating species from the western United States, or even Europe, will stray in to be recorded for the first time.

The evening of October 5, 1954, was favorable for a large southern migration of the smaller species of birds that migrate only at night. Fog, drizzle, and overcast had set in, however, and many of the migrants, flying lower than usual. were lured to their death when, like moths to a flame, they were attracted to the lights on towers and skyscrapers. At the tower at the Air Force base at Westhampton, Long Island, about 75 miles from New York City. 596 birds of 47 species were picked up. Among them were 24 Scarlet Tanagers, 114 Blackpoll Warblers, 46 Swamp Sparrows, and 13 Connecticut Warblers. The last-named is a relatively rare and elusive species, and even experienced birders are happy if they see one or two during a season.

Until the searchlights on the Empire State Building were turned off during the height of the seasonal migration, large kills of birds occasionally occurred there. Basketfuls of their small, bedraggled bodies were brought to The American Museum and dumped out on laboratory tables for identification and such scientific use as could be made of them. In recent years, the tall television towers being constructed around the country extend well up into the heights at which small migrating birds fly in cloudy weather, and the total kill is sometimes enormous.

Our party checks in with the warden at Jamaica Bay Refuge, a bird sanctuary in New York City's limits, pauses until the roar of a jet taking off from nearby Kennedy Airport has lessened, and sets out to walk along the diked road around the West Pond. On the shore off to the left, several score of brant, whose breeding grounds in northernmos Canada and Greenland are still frozen, have delayed their departure well into May. For the most part however, the many birds that we now see in the sanctuary will remain and nest. Their variety is indeed startling.

Glossy Ibises are actually common; as recently as twenty-five years ago, this species was considered rare anywhere in North America and was scarcely seen north of Florida. Now it nests in many places on the Atlantic coast. including here at the Jamaica Bay Refuge. Black Skimmers conspicuous in their black-and-white dress, rest on a nearby sandy nesting area. This is another bird, absen from this part of the world for decades following early persecution, tha is now re-established as a commo nesting species. Ruddy Ducks perform their courtship antics. This curious little bird, with its chestnu

Vignettes from the Journal of a New York Ornithologist

back, bright blue bill, and stiff little tail feathers, has prompted many common or familiar names given it by hunters. Some of the nicknames are comical: Bumblebee Coot, for instance, is a picturesque one.

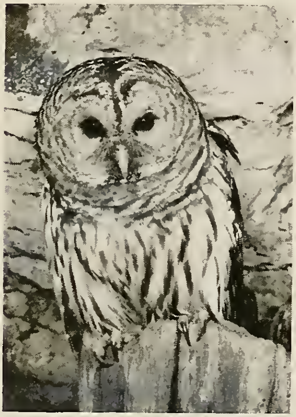
Both Snowy Egrets and Greater Egrets are seen—species that were in danger of extermination about 1900 because of the value of their plumes for the millinery trade. At that time, the few survivors were seen only in the remotest sections of the Everglades and other southern retreats. Comparing notes after our return to the refuge headquarters, we compile a lengthy list of water birds that would do credit to any place in the world.

Over in New Jersey plans have been announced for the final draining and development of the extensive salt marshes known as the Jersey Meadows, by the Hackensack River and Newark Bay. The reclaimed land, we are told, will provide sites for industry and living areas for another two hundred thousand or so people. No one bothers to mention that in the last century two ambitious attempts to drain the Jersey Meadows ended in bankruptcy; that Manhattan lies directly downwind and would be subject to air pollution from the proposed industrial development; that the New York metropolitan area certainly does not need two hundred thousand more people and would probably profit from two hundred thousand less; and that with proper management, these vast marshes might be returned to at least a measure of their primitive condition—when they teemed with shellfish, with waterfowl and shorebirds, and with furbearers.

Snowy Egret

New Hat

Screech Owl



Barred Owl

Birders

In December of 1956, Paul Buckley, Geoffrey Carleton, Peter Post, and Robert Scully spent an uneventful day birding on the Jones Beach strip—part of a series of barrier beaches off the south shore of Long Island. Toward evening they visited a grove of pine trees at Cedar Beach, on the chance that a Barn Owl that had wintered there three years before might be back. Sure enough, the Barn Owl flushed from the pine trees, and as they walked nearer, it was followed by a tiny Saw-whet (Acadian) Owl, smallest of our local species. On their way home, the group detected a suspicious-looking shape on a snow fence. Stopping the car and flashing their searchlight, they were delighted to see another species of owl—the Snowy Owl.

Nearer the city limits, they stopped at a favorite place near Lawrence, Long Island, to attempt to whistle up a Screech Owl. First, another Saw-whet Owl, then a Screech Owl responded to their imitations of owls' calls. The Screech Owl, however, would not come into view, and after visiting a friend in nearby Rockaway Beach, the four bird watchers decided to have another try at sighting this species. They were scarcely out of the car when the dovelike, but harsher, call of a Long-eared Owl floated in from the direction of some lawns with cedar trees.

At this point, the owl searchers were so encouraged by their unusual success in locating five species, they decided to try for all eight owls that occur, with any regularity, in the New York City region.

The next stop was at Spring Creek, now, alas, despite its name, a garbage dump. Spreading out, the four combed the area but were unsuccessful in flushing or seeing one of the Short-eared Owls that are known to winter in the area. They then visited the New York Botanical Garden in the Bronx. They arrived at 11:15 P.M. Here they imitated the hootings of various owls but received answers only from two more Screech Owls and a Saw-whet. After stopping at a Jerome Avenue diner for coffee, they proceeded to the Grassy Sprain Reservoir, arriving about 1:30 A.M. "We had hardly stopped the car when the unmistakable hooting of a Barred Owl came from across the valley Some hoots by our owl caller were followed, after several minutes, by more hoots from the bird at closer range. Occasionally we mixed in a deep call, and finally there drifted over from the ridge the deep, booming call of a Great Horned Owl—the seventh species."

The next day in a pouring rain two of the men returned to Spring Creek where they succeeded in flushing two Short-eared Owls. Their list was complete.

The Peregrine Falcon, or Duck Hawk, considered by many to be the noblest of all birds of prey, once nested on cliffs in several parts of eastern North America. A few pairs for example, nested near New York City along the cliffs of the Hudson—the Palisades. It was probably these falcons that in winter were seen in small numbers, perched high on skyscrapers and feeding on the city pigeons.

In the mid-1940's the numbers of the Peregrine Falcon began to decrease sharply. Now, as a result of careful surveys along the Appalachian chain, all the way from Quebec to Alabama, it appears doubtful if there is a pair of nesting birds of this species left in the eastern United States. This disappearance is attributed to chlorine-containing pesticides such as DDT. When a songbird feeds on insects killed by DDT, it may become weakened in its flight. It is precisely such individuals that are most apt to be caught by falcons, and thus the latter accumulate more of the pesticides than do most living creatures. The result is, infertility and, in extreme cases, death of the adult falcon. Also by some unknown reaction, the chemical apparently has

he effect of making the falcons' eggs
o thin shelled that they crack and
reak before hatching. Peregrine
alcons nesting in the Arctic are rela-
ively unaffected because they are
ess apt to pick up animals containing
DT.

Much the same fate has met several
opulations of America's national
mblem, the Bald Eagle, and also the
sprey, or Fish Hawk. The Ospreys,
hich once built their picturesque
ests in large numbers near the
outh of the Connecticut River and
n the coastal islands of eastern Long
sland, have decreased at an alarm-
ng rate. Only three or four pairs re-
ain in some areas where there were
nce thirty or forty, and even these
ew are having very poor nesting suc-
ess. Spraying with chlorinated pesti-
ides was stopped in Suffolk County
n eastern Long Island in 1968, and
dramatic increase was noticed in
e number of young Ospreys reared
n nearby Gardiner's Island. Thus
ere is hope that if the switch to
hosphate-based or other less persist-
nt forms of insecticides can be made
time, these splendid birds of prey
ay yet respond.

Osprey

If the world ever lives at peace, the
rge tracts of land now held in mili-
ry reservations may provide a sig-
ificant addition to the desperately
eeded open spaces near many of the
orld's cities. Occasionally, even
ow, military reservations that be-
ome obsolete are turned back to
vilian use. Such a one is Great Gull
land, off the eastern tip of Long
land, the site of massive military
stallations designed to guard the
uter approaches to New York Har-
or at the time of the First World
ar. Now obsolete, anything mova-
le was taken from the island, and
hat was left, including the island
self, was recently presented lock,
ock, and barrel by the United States
overnment to The American Muse-
n of National History and The Lin-
ean Society of New York.

Long-eared Owls

Roseate Terns

During the military occupatio
the large colonies of terns, or se
swallows, that nested on Great Gu
Island had almost completely disa
peared. Soon after the island's aba
donment, they made their return, an
amateur and professional naturalis
now spend time on the island eac
spring and summer, studying the b
havior and population dynamics
these sea birds. As a special ince
tive, the Roseate Tern, a relative
little known species of somewhat e
ratic distribution, began nesting
Great Gull Island in numbers almo
equaling those of the Common Ter
Thus, quite unexpectedly the metr
politan area has been provided wi
a new and thriving bird sanctuary.

A garbage scow moves slowl
down the lower Hudson River, fo
lowed by a circling, screaming floc
of Herring Gulls. Whenever the ga
bage is added to one of the land fil
—or should one say "garbage fills
—that are being formed over som
of the marsh lands hereabout, th
number of gulls that congregate du
ing the winter months to feed on th
bounty is truly staggering. Va
flocks, numbering in the tens of thou
sands, take wing as the trucks pull i
to dump their loads.

Locally these gulls do no partic
lar harm, though, when they leave th
garbage dump to rest in large nun
bers on reservoir waters used f
human consumption, one regrets th
chlorination is being put to suc
a severe test. On their nestin
grounds, however—the coast and i
lands from eastern Long Island
even farther south, then north int
New England and Canada—the i
creasing hordes of Herring Gul
have become a real menace to smalle
species. The daintier and more a
tractive terns have completely disa
peared from many of their forme
nesting haunts.

Thus, man, by providing a vastl
greater artificial food supply du
ing the critical winter months, ha

brought about a tremendous increase in Herring Gulls and a decrease in other, generally more attractive and useful, species. This seems to be a common result of human management or mismanagement of the environment. It is true not only in urban situations, such as that just described, but also in agricultural areas where today's methods of large-scale land tilling result in enormous increases in species such as blackbirds.

Herring Gulls and blackbirds are, at any rate, native species. The starlings, which roost in vast numbers on the metalwork under the Riverside Drive viaduct at 125th Street and in other places around the city during the winter, are not. Like various other birds they were brought over from Europe and released under one misguided impulse or another. During the short winter days these starlings spread far and wide, ten or fifteen miles from their roost—thousands of them crossing the Hudson into New Jersey every day. There, and on Long Island, they may descend at suburban bird feeders and frighten away the native birds. In the summer they are even more of a pest, as they evict bluebirds and flickers from their nesting burrows. A little later in the year they roost in the shade trees and threaten the tranquility of even the White House.

As I write this, I pause to gaze out the window. Across Central Park West, the north-south street that runs in front of The American Museum, a man is rummaging through a trash can into which school children have thrown the refuse from their box lunches. He salvages all the bits of bread crusts or other food and carefully puts them into a bag. Then, walking across the street and around the corner, he throws this bounty on the pavement for grateful flocks of pigeons, which descend from all directions. Everyone likes a few pigeons, but, as with the Herring Gulls, a much augmented food supply permits them to increase out of bounds.

Has our little man heard about the human diseases sometimes carried by pigeons? Probably not. Or, if we questioned him, we might find that his love for the pigeons is balanced

Common Egret

Yellow-throat

Blue Jay

(if one may use that term) by an equal lack of affection for his fellow man. Be that as it may, as a result of man's mismanagement of his environment, both designed and unintentional, city and suburban dwellers often see a great many introduced or less attractive birds and relatively few of the more beautiful and beneficial songbirds.

Scarlet Tanager

Red-winged Blackbird

Catbird

The housewife speaks to a boy in a suburban supermarket: "Fred, will you please carry a 25-pound bag of sunflower seed out to my car?"

"Sorry, Mrs. Johnson, all sold out."

"But I saw a truckload of it being piled here this morning."

"I know, but we just can't keep it in stock."

In suburbia, a large percentage of the homes now have bird feeders. Bluejays and gray squirrels, it is true, account for the consumption of much of the sunflower seed and other food provided. But there are other, better results of this vast increase in the number of bird feeders and bird watchers throughout the United States. Evening Grosbeaks, for whatever reason, have extended their nesting range across the northern forests to the Atlantic coast in Quebec and Maine. Not too many years ago they were rare, even as far east as northern Minnesota. I suspect that the soaring number of bird feeders may have played an important role in this range extension.

California House Finches, introduced on Long Island a few years ago, when birds confiscated from a pet dealer were turned loose, have multiplied and spread. Now they are found in all the suburban areas near New York and are turning up at more distant points. Beautiful songsters, the male brightly colored, they are plucky enough to fend off the less attractive English Sparrows.

Probably the House Finch could not have survived and multiplied in

ıe northeast without feeding sta-
ons to fall back upon in winter.
ertainly it would not be found in
resent numbers. The same is true of
ıat splendid songster, the Cardinal.
n former days, their numbers were
ecimated in the north by every
evere winter. Now that the winter
ood problem has been solved, they
ave increased tremendously.

And, of course, the suburban bird
atchers are always entertained by
ıe old standbys—chickadees, nut-
atches, Downy and Hairy Wood-
eckers—with an occasional rarity to
dd excitement.

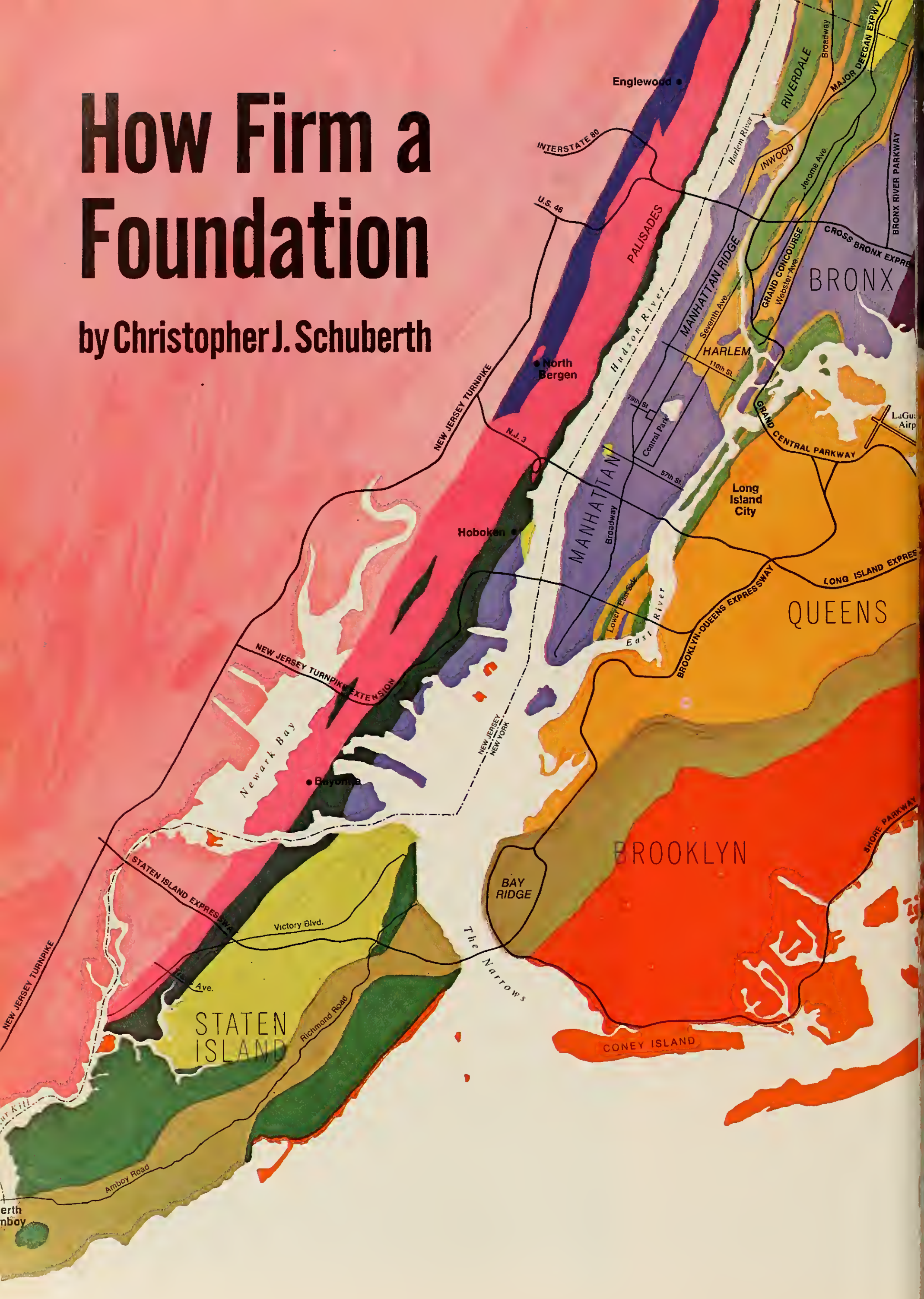
Thus, when the entire spectrum of
ıan's relationship to living birds in
great metropolitan area like New
ork is surveyed, one finds that
ıuch has been lost, a little has been
aved, and a few new things have
een added. The total trend, how-
ver, can only be considered nega-
ve, total loss of some species and a
reat increase of a few undesirable
nes. Many of the trends that have
ad a deleterious effect on bird life—
estruction of natural areas, pollu-
on of land, air, and water, to men-
on only a few of the most important
-are beginning to have a negative
nd, in the long run, perhaps even a
isastrous effect upon humans as well
s birds.

As I have written elsewhere: "But
was not until rather modern times
ıat man's impact on the environ-
ıent really became profound. The
ıdustrial revolution, large-scale
griculture and attendant destruc-
on of forests, settling of the 'new'
ontinents, and, more recently, ramp-
nt use of chemical fertilizers and
esticides are among the factors in-
olved. Dozens of species of birds
ave become extinct, and vastly more
ave decreased in numbers and dis-
ppeared from many areas. The proc-
ss has not halted but is accelerating,
npelled by the population explo-
on. One can only hope that modern
ıan will not destroy his environment
s effectively as the Mayas and some
ther vanished civilizations suc-
eeded in doing. Birds are scarcely
ıore than a pawn in these global
everberations. But, as with the caged
anaries, once used to warn of poison
as in coal mines, we may by saving
ature save mankind."

Skimmers

How Firm a Foundation

by Christopher J. Schuberth


Englewood
INTERSTATE 80
U.S. 46
PALISADES
Hudson River
Harlem River
RIVERDALE
Broadway
MAJOR DEEGAN EXPWY
INWOOD
Jerome Ave.
BRONX RIVER PARKWAY
CROSS BRONX EXPRE
BRONX
MANHATTAN RIDGE
GRAND CONCOURSE
Webster Ave.
Seventh Ave.
HARLEM
110th St.
North Bergen
79th St
Central Park
NEW JERSEY TURNPIKE
N.J. 3
57th St.
GRAND CENTRAL PARKWAY
LaGu
Airp
Long Island City
MANHATTAN
Broadway
Hoboken
LONG ISLAND EXPRES
Lower East Side
East River
QUEENS
BROOKLYN-QUEENS EXPRESSWAY
NEW JERSEY TURNPIKE EXTENSION
Newark Bay
NEW JERSEY
NEW YORK
Bayonne
BROOKLYN
SHORE PARKWAY
BAY RIDGE
STATEN ISLAND EXPRESSWAY
Victory Blvd.
The Narrows
Ave.
STATEN ISLAND
Richmond Road
CONEY ISLAND
NEW JERSEY TURNPIKE
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Amboy Road
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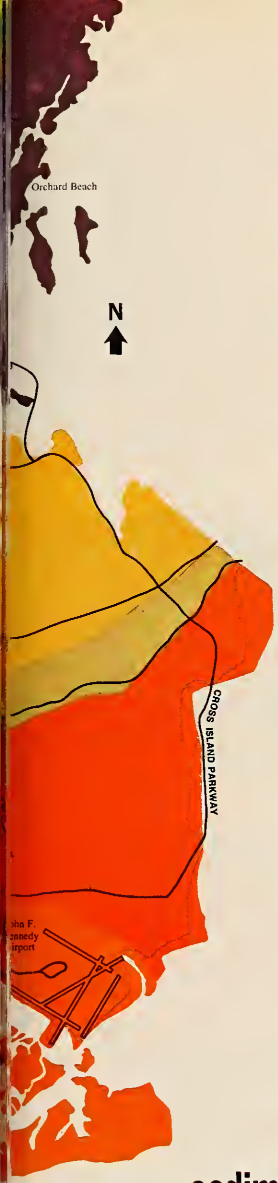


AGE			
HOLOCENE	🟧	POSTGLACIAL DEPOSITS	
PLEISTOCENE	🟧	OUTWASH	
	🟨	GROUND TILL	
	🟨	HARBOR HILL TERMINAL MORAINE	
CRETACEOUS	🟩	MAGOTHY AND RARITAN FORMATIONS (undivided)	
TRIASSIC	🟥	PALISADES DIABASE	
	🟥	BRUNSWICK FORMATION	NEWARK SERIES
	🟦	LOCKATONG FORMATION	
	🟩	STOCKTON FORMATION	
CAMBRIAN to ORDOVICIAN	🟨	SERPENTINITE	
	🟫	HUTCHINSON RIVER GROUP (May be Precambrian)	
	🟪	MANHATTAN FORMATION	NEW YORK CITY GROUP
	🟧	INWOOD FORMATION	
	🟩	FORDHAM FORMATION (May be Precambrian)	
PRECAMBRIAN	🟨	YONKERS GNEISS	

Submergence beneath the sea... sedimentation... mountain building... volcanism... these are some of the processes hat produced the bedrock upon which New Yorkers build their skyscrapers

New York's prominence in cultural, financial, and industrial affairs often obscures the fact that from the geologic viewpoint this metropolis is one of the most diversified in the United States. It is true that New York does not present the topographic grandeur of a city such as Denver or display such an assemblage of fossil-bearing strata as those exposed in Chicago, Kansas City, and many other major cities in the mid-continental region. But from a careful study of the rock record found still preserved in the five boroughs that comprise the 300-square-mile area of New York City—Manhattan, The Bronx, Brooklyn, Queens, and Staten Island—one soon learns that New York is unusual in at least two other aspects. First the area was subjected to an almost unprecedented barrage of one dynamic geologic process after another—submergence beneath the sea; sedimentation and crustal subsidence; volcanism; mountain building; metamorphism; long-term and deep erosion; more sedimentation, volcanism, and crustal instability; more erosion; resubmergence beneath the sea; continental glaciation; and the postglacial growth of coastal beaches. Consequently, New York's terrain has been molded and remolded into its present form over the immense span of geologic time by almost all the agents responsible for bringing about surface change.

Second, few urban areas of comparable size can surpass in number the more than 170 mineral varieties recovered from the 20-square-mile area of Manhattan Island alone or match some of them in size, color, or the perfection of their crystal form.

Because so much underground exploration and construction had to be carried out for the rapidly expanding city, New York's bedrock has become perhaps the best-known on this continent. Subterranean excavations, however, are not necessary for one to observe this bedrock; much of it can readily be found exposed in Manhattan and The Bronx.

For example, it can be seen in the many city parks—such as Central Park in Manhattan or the New York Botanical Garden and Zoological Park in The Bronx—in one or two of the still-vacant lots sandwiched between high-rise apartments; and along the shoulders of such highways in Manhattan as the Henry Hudson Parkway north of the George Washington Bridge, the northern end of the Harlem River Drive, or along the Cross Bronx Expressway.

Three formations of metamorphic rock have long been recognized as making up New York's basement. Each formation is a natural rock unit of sufficient areal extent to be shown on a map and—on the basis of physical appearance, mineralogy, or other distinctive identifiable features—is readily distinguished from other formations with which it is associated. Its name consists of two parts such as "Palisades Diabase or "Manhattan Formation." The first part is taken from some geographic feature where outcrops of the formation were first studied and described. The second either indicates the predominant rock type or is simply the word "formation." The name becomes official only after a full description of the formation has been published in a professional journal. This description includes not only the precise details of its physical characteristics, its thickness, and it general surface distribution, but als a notation of the "type locality," o the geographic location that provided the first description of the formation. As long as the formatio does not lose its identity as it i traced from place to place—even int another county of an adjacent stat—its formal name is not changed.

Underlying all of New York Cit is found a tough, durable, an strikingly attractive black-and-white banded gneiss known as the Fordham Formation. It is exposed, however, only along two major ridge

An evolving geology: right, turbulent surf actively reshapes a barrier island, Great South Beach; bottom, left to right, both the vertically banded Fordham gneiss (cut by a pegmatite dike) and the much deformed gneiss are roots, now exposed to view, of ancient mountain ranges.

t form the backbone of the western
rt of The Bronx: east of the
rlem River at Highbridge, Tre-
nt, University Heights, Fordham,
d north of the Harlem River
Kingsbridge; and at Riverdale.
ere the Cross Bronx Expressway
s cut through one ridge, just east
the Alexander Hamilton Bridge
r Highbridge, the Fordham For-
tion—with its tightly folded, light-
ored bands of quartz and feldspar
t alternate with the black bands of
tite—is typically exposed in the
ld cliffs, about thirty-feet high,
ich face the highway on both sides.
In contrast to the durability and
istance of the gneiss, the Inwood
rmation above it consists of an
sily weathered and erodible mar-
, which varies in color from white
brownish white, has a sugary ap-
arance, and is rich in calcite and
lomite. Because it disintegrates
d decomposes so readily, outcrop-
ngs are not common. The most
tensive is in Isham Park at Man-
ttan's northern end, known as In-
od. Two other neighborhoods in
nhattan underlain by the Inwood
rmation include Harlem and the
rlem River Valley and, at the
illiamsburg Bridge, the Lower
st Side. In The Bronx, the valleys
cupied by the Major Deegan Ex-
essway, Broadway, Webster
enue, and Jerome Avenue south
Tremont Avenue, follow long,
rrow bands of marble. However,
th the exception of an outcrop or
o along Webster and Jerome
enues, the Inwood Formation lies
mpletely concealed beneath the
el and concrete of New York's
ements and streets.

he Inwood Formation, in turn, is
erlain by the best-known of New
rk City's rock formations, the
anhattan Formation. It is mostly a
dium- to coarse-grained schist,
very gray when freshly exposed,
at is as tough and durable as the
eiss of the Fordham Formation.
e schist is primarily composed of
artz, feldspar, and dome garnet,
t is dominated by flakes of platy
ca, which are clearly aligned par-
el to one another, imparting a dis-
ctive schistose structure to this
rock. While it underlies almost all of Manhattan Island, north of 110th Street and west of Seventh Avenue in Harlem it forms the rugged, but narrow, Manhattan Ridge. This ridge is known locally as Morningside Heights in the vicinity of Columbia University near 116th Street, as St. Nicholas Heights in the vicinity of The City College of the City University of New York near 137th Street, and as Washington Heights in the vicinity of The Cloisters and Fort Tryon Park near the George Washington Bridge. Near 155th Street and the Harlem River Drive, Coogan's Bluff—an east-facing escarpment of St. Nicholas Heights—is still known to many New Yorkers as the brooding, silent monolith that once towered over the now demolished Polo Grounds. In The Bronx, the southern half of the Grand Concourse follows a narrow ridge of mica schist, but the broadest area underlain by the Manhattan Formation is east of Webster Avenue, where it includes such focal points as the New York Botanical Garden, the Bronx Zoo, and Crotona Park.

The Fordham, Inwood, and Manhattan Formations comprise the New York City Group and are also identified as such north of New York City. Most of Westchester County and southwestern Fairfield County in Connecticut, as far as Danbury, is underlain by the New York City Group.

About one mile east of the Bronx River Parkway, in a large area of the East Bronx that includes Pelham Bay Park and Orchard Beach, a second group of metamorphic rocks has been recognized, which only recently has come under intensive study. Originally identified merely as "schist and gneiss undivided," but now called the Hutchinson River Group, further research is required before it will be possible to correlate this group with the New York City Group to the west.

Penetrating these two groups of metamorphic rocks are numerous, long, slender, sheetlike masses of granite pegmatite, which rarely exceed a thickness of fifteen feet. As the commonly seen dike, the granite pegmatite cuts across the banding of the gneiss and the schistose structure of the Manhattan Formation. As the less common sill, the intrusive igneous rock parallels the layering of the enclosing rock. This igneous rock formed when magma impregnated the already existing schist and gneiss and crystallized into solid rock upon cooling. From the dikes and sills of this exceptionally coarse-textured rock have been recovered many exquisitely formed crystals of exceedingly large size. A 10-pound garnet crystal from Broadway and 35th Street, a 9-inch-long, 10-pound tourmaline crystal from Fort Washington Avenue and 171st Street, and, at Riverside Drive and 93rd Street, one of the finest chrysoberyl crystals discovered in North America represent only a few of the 170 or so kinds of minerals recovered in Manhattan from these pegmatites and the associated mica schist.

Until recently the age of New York City's bedrock was a matter of much conjecture and considerable dispute. But modern geochemical techniques have shed some light on this question and, by employing two well-tested methods—measuring the amount of potassium that has disintegrated into argon and the same for rubidium-strontium—radiometric ages have been obtained for more than forty samples of mica and hornblende separated from the metamorphic rocks of the New York City Group. From these studies it was determined that the earliest episode of metamorphism occurred about 480 million years ago. However, evidence obtained primarily from the pegmatites clearly indicates the occurrence of a later metamorphic episode about 360 million years ago, one accompanied by the emplacement of the pegmatite dikes and sills.

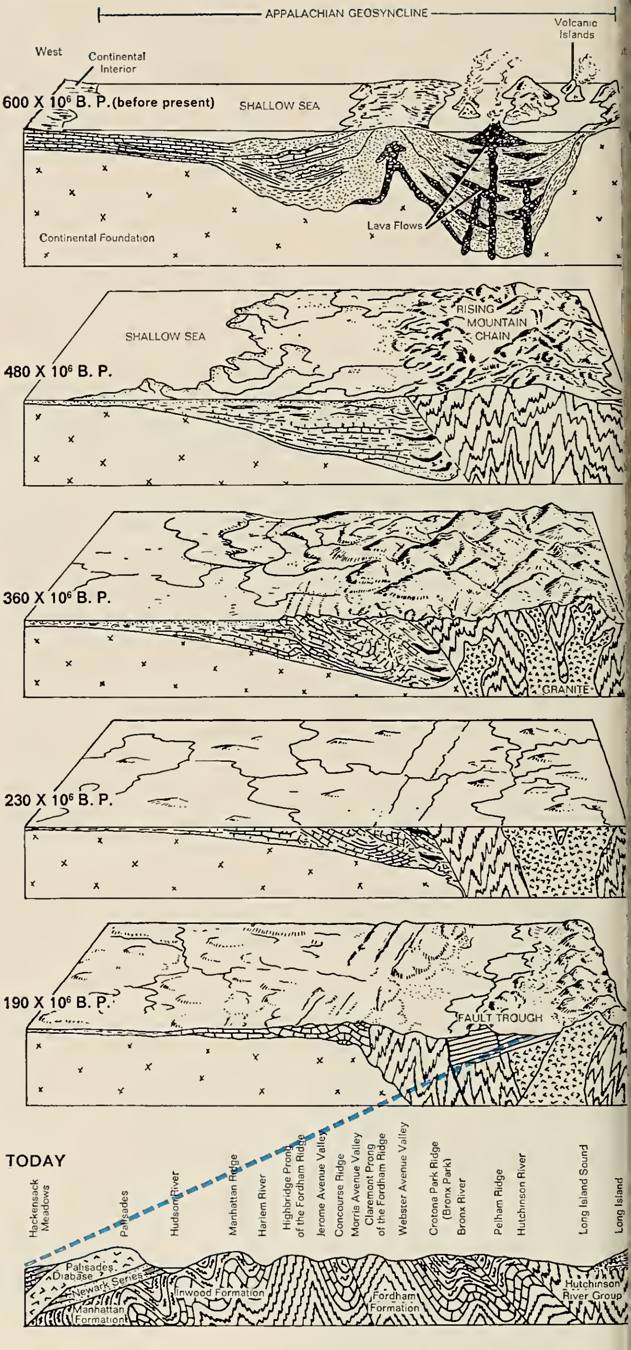
A question not fully answered, however, centers around the age of the original, unmetamorphosed rocks, which everyone agrees were sedimentary, but for which no radiometric age can be obtained. While some favor them to be Late Precambrian, perhaps 700 or so million years old, others favor a Cambrian to Early Ordovician age of between 500 and 600 million years. Still others suggest a Precambrian age for the sedimentary antecedent of the Fordham Formation, a Cambrian age for the antecedent of the Inwood Formation, and an Early Ordovician age for the antecedent of the Manhattan Formation.

While much has been learned about the geologic evolution of New York's bedrock, much of the record either is frustratingly incomplete, or has been so profoundly altered that conclusions are, at best, only tenuous. This problem, however, is not unique; it applies to all terrains where deep-seated regional metamorphism was in effect during the long course of earth history. From an evaluation of the remaining fragmentary record—not only in New York City but also beyond its northern boundary—coupled with the fundamental assumption that the kinds of geologic processes that operated in the primordial past were like those changing the earth today, a generalized geologic history of New York's bedrock can be reconstructed.

Beginning about 700 million years ago, all of New York City, as well as the rest of eastern North America for that matter, became the site of a geosyncline—a long, narrow trough covered by a shallow sea, which received sediments not only from an older continental land mass to the west but also from an archipelago of mostly volcanic islands to the east. As these sediments, together with lava, volcanic ash, and dust ejected from the offshore volcanic islands, accumulated in the geosyncline, the floor continued to sag sufficiently, so that a reasonably constant water depth of several hundred feet was maintained during this time of sedimentary filling. Perhaps as much as 50,000 feet of marine sediments—compacted into sedimentary rock—plus volcanic materials, were deposited in the geosyncline during the next 200 million years or so.

Then, about 480 million years ago, during the Ordovician Period, pressure deep within the crust began to drastically reshape the geosyncline. Just why this trough is buckled downward into deeper portions of the crust while the sedimentary mass is elevated high above sea level is not

Sequence of Changes in Metropolitan New York's Landsca


APPALACHIAN GEOSYNCLINE
Volcanic Islands
West
Continental Interior
600 X 10^6 B. P.(before present)
SHALLOW SEA
Lava Flows
Continental Foundation
480 X 10^6 B. P.
SHALLOW SEA
RISING MOUNTAIN CHAIN
360 X 10^6 B. P.
GRANITE
230 X 10^6 B. P.
190 X 10^6 B. P.
FAULT TROUGH
TODAY
Hackensack Meadows
Palisades
Hudson River
Manhattan Ridge
Harlem River
Highbridge Prong of the Fordham Ridge
Jerome Avenue Valley
Concourse Ridge
Morris Avenue Valley
Claremont Prong of the Fordham Ridge
Webster Avenue Valley
Crotona Park Ridge (Bronx Park)
Bronx River
Pelham Ridge
Hutchinson River
Long Island Sound
Long Island
Palisades Diabase
Newark Series
Manhattan Formation
Inwood Formation
Fordham Formation
Hutchinson River Group

early understood. But by the end the Ordovician, a portion of the osyncline no longer was a site of dimentation; instead, the thick se- ence of sedimentary strata was lded into a mountain chain of con- derable stature, perhaps as majestic nd extensive as are our present-day ockies. Most of this high-standing ountain range—like an iceberg ating in denser water—consisted deep roots, extending at that time rhaps as much as 30,000 feet or ore beneath the surface of what day is New York City.

he sedimentary strata deep in the ot zone were particularly affected this episode of severe crustal dis- acement and deformation, better nown as an orogeny. The intense essure and high temperature asso- ated with the orogeny work to- ether to permit the transfer of chem- al elements and the development of w minerals that are visibly much rger than those in the original sedi- entary rock. In order to undergo ese changes, the original sedimen- ry rock becomes mobile, flowing astically like tar, then recrystallizes to coarser-textured metamorphic ck. It seems that a sandstone was crystallized into the intensely de- rmed black-and-white-banded neiss of the Fordham Formation, mestone into the dolomitic marble f the Inwood Formation, and sandy ale into the mica schist of the Man- attan Formation. Some 120 million ars later, during a second phase of arked crustal instability near the d of the Devonian Period, the sills d dikes of pegmatite were forcibly jected into the already formed met- morphic rocks as they lay deeply uried within the crust.

Sills and dikes of pegmatite, how- ver, are not the only igneous rock pes found associated with the New ork City and Hutchinson River roups. Scattered and isolated asses of serpentine rock, or serpen- nite, also occur. Extensive outcrops re rare, but one of the largest, more an thirty-five square miles, makes p the core of Staten Island. Serpen- nite appears to be the alteration roduct of other igneous rock types ch as peridotite or pyroxenite, which were altered by water and other chemically active fluids in an environment of high temperature and pressure far below the earth's surface. Most of the resulting serpentinite is of the nonfibrous variety of the mineral serpentine called antigorite. There is also some fibrous serpentine, called chrysotile, and talc. One other mineral should also be mentioned. It was discovered in New York City early in 1967 at fresh exposures of the serpentinite in Staten Island off Richmond Road. Extremely delicate crystals of artinite, chemically a hydrous magnesium carbonate, are found as a rare occurrence in only three other state—New Jersey, Pennsylvania, and California. On Staten Island, the artinite is typically in fine white needles, usually less than 1 mm. thick and up to 2 cm. long, either as ball-shaped tufts 1 to 2 cm. in diameter, or as a drusy carpet that covers the surface of the bright, pistachio-green serpentinite.

Most of the serpentinite in New York City is identified from core samples obtained during exploratory drilling for highways, aqueducts, and so on. When correlated with other samples on a regional basis, they appear to be aligned along what is the major axis of the mountain system that rose out of the geosyncline nearly a half billion years ago. Since serpentinites are so persistently associated with a mountain system and do not occur outside it, they must, in some way, be related to the mountain-building processes. Some geologists have suggested the serpentinite represents an early phase in the intrusive cycle during an orogeny. In New York City it may well predate the emplacement of the pegmatites. Unfortunately, no radiometric ages have as yet been obtained, so the origin and history of the serpentinite in New York City is still in question.

Even as the young mountains were forming, wind and weather began whittling them into craggy peaks. As streams ground their channels ever more deeply into the mountain system, they removed a vast amount of rock, and the mountain chain responded by continually rising. Like a giant iceberg from which ice is removed, thereby permitting the submerged portion to slowly approach the water's surface, the metamorphic rocks formed deep within the root zone of these mountains rose to the surface during the next 200 million years. Just how much rock was removed during this interval of long-term deep erosion is difficult to estimate. It may have been as much as 300,000 cubic miles or more.

By the middle of the Triassic Period, about 190 million years before the present, the metamorphic bedrock we recognize in New York City lay exposed on the surface. Today, the New York City and Hutchinson River Groups, once buried more than five miles below the earth's surface early in the Paleozoic Era, are the remnants of the former mountain system that rose out of the geosyncline. From them has been reconstructed this capsule summary of New York's Paleozoic history.

But another 190 million years must still be accounted for. To examine a portion of this post-Paleozoic record, let us turn to Staten Island and, excluding its core of serpentinite, study the rock record available in this most isolated of New York's five boroughs.

The long cycle of erosion that destroyed the mountain system was followed by another episode of marked crustal instability. Perhaps a lightening of the earth's crust by the removal of such a vast load of rock from the Paleozoic mountains caused it to be buoyed upward. Fracturing the crust along major fault zones, the uplifting forces raised giant blocks to form mountains, and the blocks between them became basins. During the latter part of the Triassic, thousands of feet of sediments, removed from the surrounding fault-block mountains, were deposited in the intermontane basins as nearly flat, broadly coalescing alluvial fans. Today, the rift valleys and adjacent highlands of central and northeast Africa, or the bare mountains with their alluvial fans filling the broad, intervening basins of Nevada, western New Mexico, southern Arizona, California, and northern Mexico are the landscapes that most resemble the Late Triassic of eastern North Ameri-

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ca. Just how many fault-block mountains and intermontane basins developed during the Triassic is not known. Only the remnants of one of these basins, called the Newark Basin, is found preserved in the New York area.

The sedimentary filling of the Newark Basin—in northeastern New Jersey and southeastern New York State, is wedge-shaped in cross section, with the strata gently inclined to the west about fifteen degrees from the horizontal. About twenty-five miles west of midtown Manhattan—at the western limit of the basin near Boonton, New Jersey, or Suffern, New York—where it is bounded by a major fault zone, the sedimentary thickness is estimated at about 15,000 feet. Since subsidence of the basin during the Triassic Period was most active along this fault zone, the sediments supplied from the surrounding highlands are at their thickest in this western portion. Thinning eastward, the sedimentary strata pinch out beneath the waters of the Hudson, and do not occur on the east side of the valley.

Although three formations of sedimentary rock, the Stockton, Lockatong, and Brunswick—collectively called the Newark Series—are identified in the Newark Basin, only two, the Stockton and Brunswick, occur on Staten Island. The older of the two, the Stockton Formation, consists chiefly of light-colored arkose, a sandstone with much unaltered feldspar. It was popular at the turn of this century for constructing the then fashionable "brownstone houses" that are still seen in many neighborhoods of Manhattan and Brooklyn. The Brunswick Formation consists chiefly of soft red shale and some sandstone. Outcroppings of the Newark Series on Staten Island are almost nonexistent; information about these two formations comes from drill core data and from outcroppings elsewhere in New Jersey.

Outside Staten Island, particularly in northeastern New Jersey, fossils of a diverse reptile fauna have been collected, many from the Lockatong Formation at North Bergen, just about three miles west of The American Museum of Natural History (*see* "The Hudson's Six Geologies," NATURAL HISTORY, January, 1967). These include a hitherto unknown lizard capable of flight and predating by about 20 million years the oldest fossils of winged vertebrates ever discovered, several kinds of freshwate fishes, and even small dinosau tracks.

Late in the Triassic, as the Newar Basin became filled with thousand of feet of sediments, deep-reachin faults became the passageways alon which the magma moved upward Much of it solidified before reachin the surface to form the scenic cliff of today's Palisades, along the wes bank of the Hudson opposite Ne York City. Forcibly injected betwee the sedimentary layers of the Stockton and Lockatong Formations, th magma congealed into a diabase fa underground. Where still complete this sill is estimated to be about 1,00 feet thick. But where exposed by erosion, as seen along the west shore o the Hudson, less than half of the original thickness remains.

Extending southward without interruption from Haverstraw, Ne York on the west bank of the Hudson the Palisade ridge gradually decreases in elevation; finally, forty-five miles from Haverstraw, the diabase disappears underground nea Victory Boulevard and Travis Avenue on Staten Island.

Where the ridge is boldly exposed the long, almost continuous column give the Palisades the appearance o a colonial stockade, or palisade hence the name. Each of the long vertical columns of diabase reveale in the cliffs is ideally a hexagona prism produced during the late stage of the underground cooling of th magma during the Triassic Period The stresses set up in the contracting mass were most easily released by hexagonal break pattern, which produced the columns perpendicular t the upper and lower borders of th sill. Trap, from the Swedish *trapp* meaning stairs, is frequently applie to the diabase because of the steplik configuration imparted by the numerous horizontal fractures. Th compact nature of this rock gives i great wearing power. Consequently traprock is valued for use as riprap the very large blocks used in revetments to protect bluffs and othe landforms exposed to wave erosion; or as aggregate, the crushed gravel-sized stone used in concrete required for heavy service.

No record of the Jurassic Period, from 190 million to 135 million years before the present, exists in eastern

North America—the agencies of erosion had again reduced the high terrain to low hills. But poorly consolidated layers of brightly colored gravel, sand, and clay that were formed late in the following period—the Cretaceous, about 80 million years ago—occur on Staten Island. Outcroppings are rare; most occur along Arthur Kill near the Outerbridge Crossing. In Brooklyn and Queens, core samples collected in wells drilled deep underground, give evidence that these Late Cretaceous sediments also occur in these two boroughs. But they lie concealed beneath a cover of post-Cretaceous glacial deposits, and with the exception of one or two isolated outcrops in Long Island City, the New York City Group in Brooklyn and Queens lies concealed beneath both these Late Cretaceous and post-Cretaceous glacial deposits.

It might be noted here that the two major waterways in New York City, the Hudson and East rivers, conveniently separate areas of contrasting geologic terrains. The Hudson separates the Triassic strata of the Newark Series from the pre-Triassic New York City Group; the East River separates the New York City and Hutchinson River Groups from the unconsolidated sediments of Late Cretaceous age and the glacial deposits that cover Brooklyn and Queens.

Although only two formations of Late Cretaceous age are recognized, the older Raritan Formation and the younger Magothy Formation, the physical characteristics common to both often make it difficult to distinguish one from the other. Plant debris, including many leaves from a diverse flora, cones, and lignite, occurs in these formations. All the evidence gathered from detailed studies indicates the ocean bordering eastern North America periodically shifted its shoreline—either because of changes in sea level, or more likely, because of a gentle raising and lowering of the eastern portion of the continent—and flooded the deeply eroded, low-lying, and almost featureless land mass several times. Just how often these seas invaded the continent and how far to the west of the present shoreline they extended is difficult to reconstruct from these remaining Late Cretaceous strata.

For the next 69 million years, the Tertiary Period, no sedimentary record is preserved in this city. The seas that flooded the eastern North

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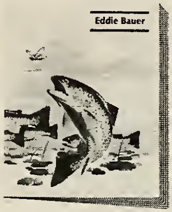

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American continent during the latter part of the Cretaceous Period may have continued to do so during the Tertiary, although New York City provides no evidence to substantiate or dismiss this idea. Instead, in Brooklyn and Queens, the Late Cretaceous Raritan and Magothy Formations are directly overlain by deposits that clearly indicate that, late in the geologic evolution of this city, a drastic change in climate brought arctic conditions to this region. Some thirty to forty thousand years ago, late in the Pleistocene Epoch, an ice sheet more than a thousand feet thick crept southward across eastern Canada and New England, and went on to cover all of Manhattan and The Bronx, most of Staten Island, and the northern portions of Brooklyn and Queens with ice several hundred feet thick.

Parallel scratches that mark the direction of glacial flow abound on the ice-polished bedrock surfaces in Manhattan and The Bronx. Many of the hills of mica schist and gneiss were resculptured by ice and reveal a distinctively asymmetrical shape: the now-gentle, much polished, abraded, and striated slope facing north; the opposite, south-facing slope steepened by the plucking action of the ice as it rode over the rocky knob. These *rôches moutonnées*—from the French for "rocks" and "sheep" (because of the asymmetrical shape of sheep lying in the pasture)—indicate glacier movement from north to south.

When the ice melted northward beginning some 13,000 years ago, it left its rock debris, often composed of exceptionally large boulders known as erratics, spread unevenly over the land, so that today much of the bedrock is effectively concealed by this glacial till. A terminal moraine, where the till was piled higher and thicker forming a distinct line of low hills, marks the position of the glacier's farthest advance. Underlying much of the high ground through the middle of Brooklyn and Queens—Bay Ridge in Brooklyn and Forest Hills in Queens, for example—this moraine crosses the mouth of Upper New York Bay and, at The Narrows, the line of encircling hills is breached by the sea.

Protected by this constriction, ships of all sizes and types sail under the gracefully arching Verrazano-Narrows Bridge, the longest suspension bridge in the world, to ride at anchor in the quieter waters of the Upper Bay and wait their turn to load or unload cargo alongside the array of docks extending from the shores of Manhattan and Brooklyn. West of The Narrows, the terminal moraine crosses the eastern portion of Staten Island and enters the mainland at Perth Amboy, New Jersey.

South of this moraine, in Brooklyn and Queens, a broad plain composed of stratified layers of gravel and sand, carried beyond the stabilized ice front by meltwater streams, extends gently down to the Atlantic shore. After the ice sheet withdrew, waves—formed in the shoaling waters along the submerged portion of this outwash plain—moved sand into position above the high-tide line. Wind and waves working together developed such barrier islands as Coney Island in Brooklyn, which is artificially attached to the mainland by landfill; Rockaway Beach in Queens; and farther east in Nassau and Suffolk Counties, Long Beach, Jones Beach, and the thirty-mile-long Great South Beach—more popularly known as Fire Island.

These fragile outposts are the battleground on which neither antagonist, sand nor surf, can claim permanent victory. But standing on the lonely beach on a stormy midwinter day, witnessing this struggle between land and sea, watching the sand respond with subtle sensitivity to the waves sweeping broadside onto the beach face, one can place in new perspective the magnitude of events in the long course of earth history. In the vastness of geologic time, New York has taken on many forms. Today, Manhattan's skyline, its bridges and tunnels, its highways and aqueducts all stand as bold monuments to man's architectural and engineering genius. Despite its seeming permanence, ours is only a momentary scene in the great design of change, the patterns of which began to emerge about 700 million years ago at the dawn of the Paleozoic Era in a shallow sea bordered on the east by an island archipelago—the changing patterns that, to this day, have not ceased, nor will they do so in the far, far distant future.

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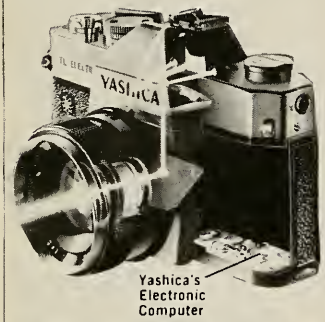

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Urban Snakes

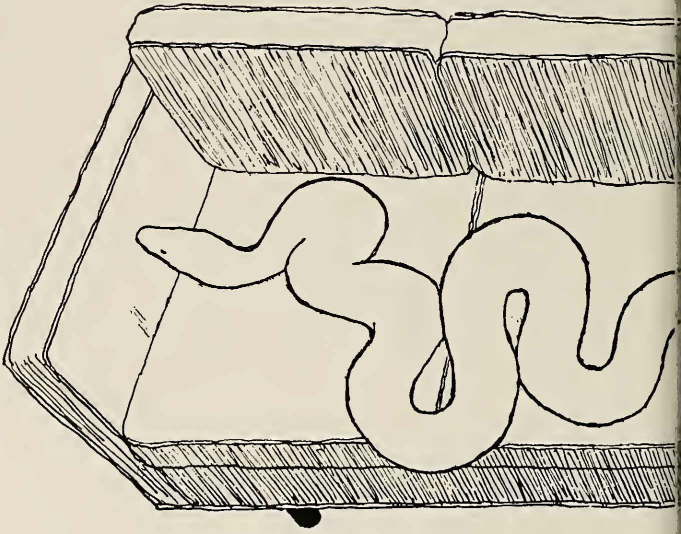
by Herndon G. Dowling

Although it has been more than two hundred years since the last native copperhead was seen on Manhattan Island, and several decades since a group of small boys clubbed to death the last garter snake to be found in Central Park, phones at The American Museum and at the Bronx and Staten Island zoos are kept ringing by people confronted by problems with snakes. Every year there are more cases: snakes found or lost, sick or pregnant snakes, and, increasingly, snake-bitten humans.

The problems, of course, do not come from native snakes, but from the many exotic species that are shipped or brought into the city. Hundreds of these are kept in New York apartments as pets. Aside from dogs, cats, cage birds, and turtles, snakes probably outnumber all other kinds of air-breathing city pets. Most pet snakes are no danger to their owners or to the neighbors. They are, however, first-class escape artists, and if the owner does not know enough to treat his snake as one it may well end up in the wrong apartment.

One recent caller who phoned the Museum seemed to be on the receiving end of such a case. From long experience with such calls, I asked her to describe the unwelcome visitor. "It's about five feet long, almost as thick as my arm, and has big black spots on a tan background." Even though she was uncommonly calm, I reduced the estimated length to half (a standard practice), but it still sounded like a perfectly good snake, so I promised to help. The lady's fourth-floor apartment was on Riverside Drive, not far from the Museum, and when my associate George Foley rang the doorbell and introduced himself, she led him to the bathroom and pointed to the tub. This time the phoned-in description was correct. There was the five-foot, black-and-tan snake, all right: a western bullsnake (*Pituophis melanoleucus*), big and showy but perfectly harmless—an ideal pet snake.

The sequel came less than a week later. A young boy's voice asked over the phone if I could suggest where he might look for a lost snake. It seemed that he lived on the sixth



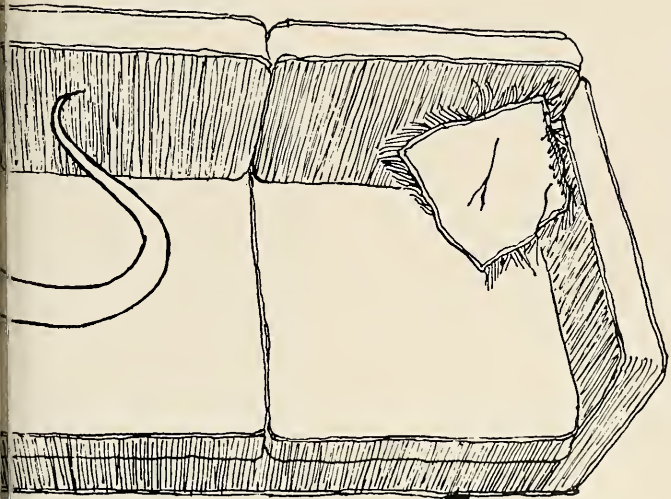
n Identity Crisis

floor of an apartment house on Riverside Drive, and he had left the window open just a little bit. . . .

Some New Yorkers keep snakes in their apartments, not as pets but as a part of their professional equipment. I remember the old-style "snake dancer" who spent the summers on the carnival circuit and the winters in her New York apartment with her two ten-foot Indian pythons (*Python molurus*). She used to call regularly to report on the health of her pets and to thank me once more for suggesting the heating pads that "solved their feeding problems." Then there was the young "exotic dancer" of local fame who decided to get a big boa constrictor (*Boa constrictor*) to use in her act, "because the other girls [in the show] always copy everything I do, and I want to stop them." And of course, I'll always remember the snake charmer from one of the North African pavilions at the World's Fair: He left a box of live Egyptian cobras (*Naja haje*) when he returned to his homeland—a box that was found by a wrecking crew and brought to me two months later with some of its inmates still viable.

Many New Yorkers keep snakes just because they like them as pets. To some people snakes are especially desirable because they do not have the fur or feathers that set off their owners' allergic responses to more common pets. Other people have no such special reasons, but point out that snakes are beautifully colored and patterned animals that require little care. They do not have to be walked, vaccinated, or licensed. They do not chew on the furniture, scratch up the floors, or bark at visitors. Though generally specific about their diet, they eat only a fraction of the amount consumed by most pets (can you imagine a cat being satisfied with a mouse every second week?) and do not require even this on a regular schedule.

Some people have even been able to train their snakes away from their usual whole-animal fare. There never has been any truth in the so-called live food requirement of snakes. Many a garter snake has survived on pieces of raw fish, and a lady physiologist I know worked out the simplest of adequate diets for her king snake (*Lampropeltis getulus*). Each week she removed the neck and gizzard



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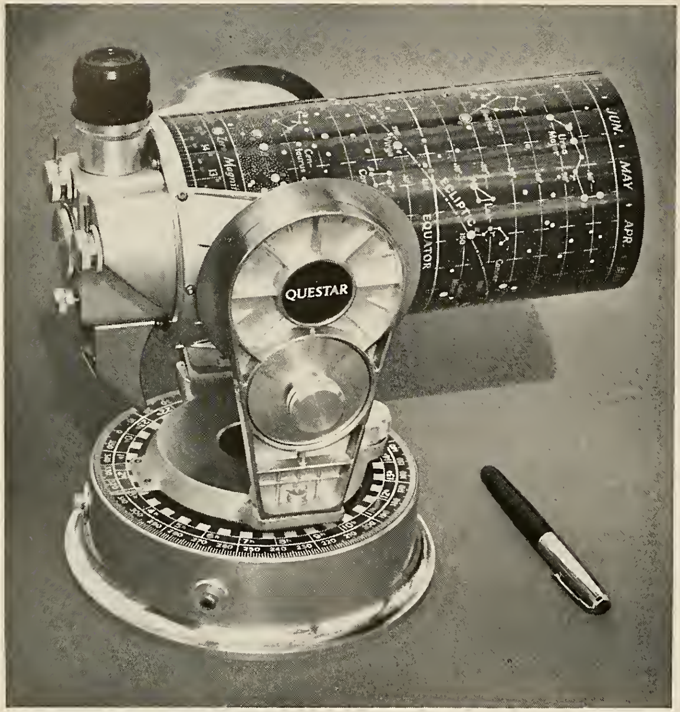

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from the Sunday chicken before cooking it and fed them—the gizzard stuffed with vitamin pills—to the snake. At first she had to rub some mouse fur on the food to give it the right scent. After a few times, though, the snake recognized its dinner without the scent.

Another often mentioned advantage of having a snake as a pet is the lack of pressure to be home for feeding time. A missed meal for a cat or dog can be a major problem, but a snake may not notice a missed meal for a week or two—even for a month or two. If the owner provides adequate warmth and water for a well-fed snake, he can go off on a three-week vacation with a clear conscience.

The snakes that are kept as pets are as varied as the people who keep them. Some are exotic indeed! Probably the most commonly kept snake in New York is the boa constrictor. Once considered a great danger, this tropical American snake rarely attains a length of twelve feet. Most are six to eight feet long as adults and of no danger to anyone. They do give birth to large litters—50 or more—of living young, and these are the ones that usually appear on the pet market. The name "boa constrictor" catches the ear, and the price, $2.50 to $10.00, catches the eye.

People will keep certain snakes as pets in spite of their sometimes expensive feeding habits. There was a music teacher who kept his fifteen-foot Indian python in a large trunk during the day but allowed it to roam about his apartment in the evening. "How relaxing it is," he told me, "to come home after a hard day's work, let out the python, and run your fingers over the cool, glossy scales as he glides out of the trunk." Finally, however, the fifteen to twenty pounds of rabbit (a hard-to-get item in his community) per meal became a financial burden, and he had to give up the python for a smaller snake.

One woman I recall, an editor for a well-known women's magazine, kept a smooth green snake (*Opheodrys vernalis*) in her room—and fed it its diet of worms (*Tubifex*) with a silver spoon. Then there was the salesman who kept a basement full of pythons: seven different kinds! And a veterinarian who liked anacondas. There are more such people than you might imagine.

Overseas Nature Tours

For eight years we have been organizing group rips to investigate the natural history of Europe, Africa and the world. See summary of world rogram in opposite column. Below are details of groups now forming:

— PACIFIC COAST —

This year we hope to prove that one need not go abroad for some of the planet's most spectacular scenery and thrilling nature experiences. In 5 successive tours, starting May 10 in Southern California, we'll follow Spring's progress north, nding in July at Point Barrow on the Arctic. Emphasis will be ecological, rather than birds alone, and we expect to have a whopping good ime at it. Come for one or all of the 5 segments. See opposite column for dates, and by all means end for the detailed itineraries.

— SOUTH AMERICA —

Feature for the Fall of 1969 is a series of 3-veek tours circling South America, starting Aug. 17 in Colombia and swinging counter-clockwise around the continent. We'll go as far south as Tierra del Fuego, touch all the famous bird ob-ervation highlights of the Andes and both coasts, and end in Venezuela before Xmas. See dates in opposite column, and let us send you the itineraies.

— EUROPE —

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EUROPE SOUTH covers France's Camargue and Riviera, Switzerland's birds and alpine flora, famed Neusiedlersee on the Hungary border, and the Rhine country; May 8. **EUROPE NORTH** takes in northern Germany and covers Sweden fully to and beyond the Arctic Circle; May 29. **NORWAY**. our most popular of all, covers fjords, mountains and coastal islands in an itinerary that has become famous; June 22. These 3 tours combine into a memorable journey "north with the spring" from the Mediterranean to North Cape and the Arctic.

MEDITERRANEAN begins at Lisbon, visits Spain's famed Coto Doñana, France's Camargue, Corsiea and northern Italy; May 8. **BALKANS** starts at Venice, visiting bird and botanical highlights of Yugoslavia, Greece, Turkey, Romania and Hungary; May 29. **U.S.S.R.** starts from Prague June 22, covers natural history highlights of Poland and Russia. **SIBERIA** is a 3-wk. link in an economical round-the-world route; the Asian U.S.S.R. republics, Lake Baikal and a journey into Outer Mongolia are features; July 13. These 4 tours combine into an extraordinary nature experience.

BRITAIN, leaving May 29, is a popular broad coverage from southeast coast to north tip of Scotland. **ICELAND**, 2-week visit to this weird country, offers a choice of departures (June 28 or July 21), with a new 10-day camping trip across little-visited centre and east coast areas available between the tours, and a visit to Greenland optional at the end.

COMING IN 1970: A thrilling series in Asia starts in January with **HIMALAYAS, INDIA-CEYLON, THAILAND-CAMBODIA** and **MALAYSIA**—four connecting 3-week trips. A remarkable coverage of South Asian birds and wildflowers, combining into a memorable round-the-world experience stretching between Christmas and Easter.

CROWDER NATURE TOURS

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Most of them keep their pets well cared for and safely enclosed within the confines of their own apartments and lives. The main difficulty that the city faces is from two groups: the unknowledgeable and the show-off. The occasional combination of these two can be a real danger.

The numbers of people in these groups have increased enormously in recent years because of two developments, one technical and the other social: the huge expansion of airfreight facilities provided by the new jet planes and the sudden affluence of the young.

In the past, a boy who wanted a snake (and boys always have) had to go out and catch it himself, or save his carefully hoarded cash over a long period to buy the animal from an established dealer. Only a wealthy institution could think of importing its own reptiles. The boy, thus, had the time and opportunity to learn something about the snake that came into his possession. The dealers were relatively stable businessmen who at least knew how to keep their charges alive, and since they had to stay in business in a neighborhood, were unlikely to offer a boy a snake that was dangerous or that he would be unable to maintain.

The low cost of jet freight has changed all this. A boy can now obtain a list of available reptiles from a foreign collector or dealer and then purchase whatever his much expanded pocketbook will allow. He can get a baby python from Pakistan for $5 or a cobra from Taiwan for $3, plus the airfreight charge (which usually costs more than the snake). There is no law to prevent it, and there are a great many parents who are just not aware of what their children are up to.

This situation has literally driven the established importers and dealers of the past out of business. Their places have been taken by the practitioners of the "quick sell." New York, once the center of the animal-importing business, now does not have a single established dealer in reptiles. Snakes are sold now—along with goldfish, canaries, and baby turtles—in the "pet departments" of department and variety stores. They are sold by people who know nothing about snakes: not their food, not their care, and not even whether or not the snakes are dangerous. And

Overseas Nature Tours

— 1969 Program —

Here is a summary of our 1969 program. Space permits only brief mention of each tour, and one should, by all means, have the "Tour Catalog" with thumb-nail sketches of each trip. Early registration will save disappointment, and may be made tentatively. North America tours 2 wks., remainder of the world 3 weeks each, except as otherwise noted.

— NORTH AMERICA —

TEXAS BIRDS: Whooping cranes, Rio Grande reserves, Northeast Mexico. March 15.

TEXAS WILDFLOWERS: Separate wildflower group on above route. March 15.

ARIZONA: Popular bird tour of southeast Arizona under Dr. Robert Ohmart of University of Arizona. April 26.

CALIFORNIA: North-with-spring in parks, mtns. & off-coast islands. May 10 (3 wks.)

CASCADES: North through Oregon and Washington reserves and parks. May 31 (3 weeks.)

ALASKA: Three successive 2-wk. trips: (1) The inside passage and Yukon; (2) the central region with McKinley Park, Kenai, Kodiak and Katmai; and (3) outposts of the Aleutians, Pribilofs, Nome, St. Lawrence . . . Island, Kotzebue and Point Barrow. Series begins at Seattle June 21.

Note that the last 5 tours may be taken in continuous succession, following spring north in one great 12-week trek from the Mexico border to Point Barrow on the Arctic.

— MIDDLE AMERICA —

PANAMA: Bird concentrations of Canal Zone & Panama mountains. March 1-15.

Yucatan, Panama and Colombia are done twice a year in a continuous chain, affording a 7-week view of the bird and plant life of tropical America that is both memorable and economical. In 1969 this series starts Jan. 11 and July 19.

— SOUTH AMERICA —

COLOMBIA: World's top bird country. Two 1969 departures: March 15; Aug. 16.

ECUADOR-PERU: Heavy bird populations of jungles & high Andes, including Machu Picchu and upper Amazon. Sept. 6.

CHILE-ARGENTINA: Highlights of both coasts, plus Tierra del Fuego. Sept. 27.

BRAZIL: Iguasu Falls, the Rio coast, central jungles and the Amazon. Oct. 18.

GUIANAS-VENEZUELA: The 3 Guianas, Trinidad and highlights of Venezuela. Nov. 8.

The 5 South America tours, starting with Colombia on Aug. 16, readily combine into a remarkable grand tour of the continent.

— EUROPE —

By all means obtain the detailed announcement of our 11-tour 1969 Europe program, with its many possible combinations. See opposite column for additional information.

— AFRICA, ASIA, ETC. —

SOUTH AFRICA: This popular trip departs July 24, includes S.W. Africa and the Kalahari.

EAST AFRICA: Extremely heavy bird concentrations, many big mammals. August 14.

CENT. AFRICA-MADAGASCAR: New and promising, beginning at Victoria Falls Sept. 4.

JAPAN: Full-time birding from south tip of Kyushu to north end of Hokkaido. Optional extra week for tourist objectives. Aug. 2.

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they are sold to people who are similarly uninformed.

I heard about such a case just a few weeks ago. Pete Brazaitis of the Bronx Zoo's Reptile Department received a call from a physician at a nearby hospital. A boy had been bitten by one of two small snakes that he had bought at a discount house in Westchester County. Could Pete identify the snakes and recommend what procedure to follow? The snakes would be brought to the zoo by police car. Pete agreed, and when the car arrived a half hour later, was surprised to see not only the expected policeman but also the badly frightened boy and his concerned mother. In the seat with them, in a broken, glass-fronted case, were two small rattlesnakes!

One of the snakes was quickly identified as a western diamondback (*Crotalus atrox*)—a species not especially dangerous as a baby, but as an adult, the one that kills more people in the United States than any other. To Pete's dismay, the other snake was an even more dangerous species, a Mojave rattlesnake (*Crotalus scutulatus*). This snake has a venom unique among rattlers in the United States. The bite does not cause the violent pain and extensive local swelling of most rattlesnakes but affects the nervous system, often causing death before the bite has been recognized as serious. And this venom is not countered well by the standard snakebite antivenin.

"Which one bit you?" Pete asked, and was relieved when the boy pointed at the diamondback. "Where?" The youngster pulled his right hand from beneath his coat, showing a blue and badly swollen thumb with a rubber band tightly wrapped around it as a tourniquet! Without asking how long it had been on (it had obviously been on too long; a tourniquet, even when properly applied, should be loosened for ninety seconds every ten or fifteen minutes). Pete quickly cut it off and substituted a proper tourniquet on the upper arm.

Pete's prompt identification and action, his subsequent recommendations to the physician, and luck (it might have been the other snake) saved the boy from permanent injury, perhaps death. But the incident shows how little protected the public is from such dangers.

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Another incident shows the other side of the coin. A call from a local hospital asked if I could identify a snake that had bitten a boy and advise on treatment. The snakes (there were two of them) were loose in a room and could not be brought to the Museum, but a police car would be sent to take me to them.

We arrived at one of the large city housing complexes and were directed to the apartment by a waiting policeman. In the back room, stretched out on the radiator, were two snakes: both nonpoisonous boa constrictors! Apparently the boy had wandered into the room when his older brother was away and had tried to pick up one of the three-foot snakes. Activated by the heat of the radiator and unaccustomed to this strange touch, the boa had struck out and scratched the boy's hand. I quickly put the boas into their cage and calmed the family (and the neighbors).

But the job was only half done. We had to get to the hospital before the physician initiated treatment for snakebite! Back into the police car. We arrived at the emergency room just in time to save the boy from an uncomfortable (and possibly dangerous) injection of 10 cc. of horse serum antivenin. The doctor was ready—and the drug salesman was in the lobby with 10 more ampules (100 cc.!) "just in case." Thus, in spite of fright, tetanus injection, and other preparation for snakebite treatment, the boy survived the hazard of "snakebite" (by a nonvenomous snake) in the city.

As more snakes fall into the hands of the unknowledgeable, I expect that the number of calls to the Museum will increase. A good portion of them will surely continue to be of minor consequence: descriptions obtained from former callers include "little slimy snakes" (earthworms), "snakes with lots of little legs" (centipedes), and "a long thin snake in a puddle" (an unrecognizable beast that turned out to be a horsehair worm, a kind of nematode). But when more important calls come in, the Museum herpetologist may find himself being rushed across the city by police car or ambulance, perhaps merely to allay the fears of a boy bitten by a nonvenomous snake, but occasionally, to give advice in the case of one bitten by a highly dangerous exotic species.

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The Animal Kingdom Ball

continued from page 10

Here, in the guise of a high society ball in New York City, all creatures—protozoans as well as primates, bears as well as cocks of the rock—would come together, acknowledge their true place in the scheme of things, and demonstrate that the ultimate genetic strategy had been to produce a smashing good party, not only merely interracial but absolutely interspecific in character.

I could not, however, figure out where all this romantic creature harmony would lead. What, for example, would happen the morning after? I had to end the fantasy. Still, I nurtured a secret hope that Edward Hicks' painting, "The Peaceable Kingdom," or one of the many fairy tales involving interspecific partying, might magically come alive. I therefore found the thought of going to the real ball irresistible. I arranged for a pair of tickets, then busied myself putting together appropriate dress, which meant black tie and not, as I might have hoped, a costume mimicking some other animal.

The potentialities of a ball so named continued to haunt me. Could it be that the Animal Kingdom Ball would have nothing to do with actual animals but would instead be a kind of taxonomic quadrille, a dance offering "systematics for swingers"? That was it, I convinced myself. The ball would be nothing less than a musical salute to Linnaeus, the eighteenth-century Swedish naturalist who organized the plant and the animal kingdoms and who assigned scientific names to everything in them.

Quick, into my zoology book, a ball like this would require brushing up on the whole hierarchy of classification groups. One simply could not even appear at such a shindig without having one's taxonomic ranks absolutely straight. I found them and repeated them over: kingdom, branch, grade, phylum, class, order, family, genus and species. To make sure I had them down pat, I went the other way: species, genus, family, order, class, phylum, grade, branch, kingdom. Then, into the intermediate ranks: superclass, superorder; subgenus, subspecies. In a final flourish of preparation, I noted that the animal kingdom contained some two dozen phyla and at least 1½ to 2 million species. With an expanding sense of triumph, I considered myself extraordinarily fit.

But the taxonomic tango was not to be. Fantasy two went the way of the first. I simply could not imagine what would happen at a ball dedicated to taxonomy—and one where fine ladies and true gentlemen might, for the evening's amusement, represent various species—without broaching the limits of good taste. I mean that, as I have heard all international taxonomic conferences in botany tend to do, the ball would unquestionably end in the most furious arguing over whether a particular organism constituted a true species or whether it was merely a subspecies. Furthermore, since the accepted definition of species generally involves the question of with whom members of a particular group normally interbreed, matters would get altogether too delicate and embarrassing for a proper benefit. Therefore, reluctantly, I let the notion of a great Linnaean ball slip quietly to rest.

But I was still disturbed, for how could the Animal Kingdom Ball be just an *ordinary* ball?

On Thursday morning I took a final stab at trying to figure it out, only this time I proposed to do it more realistically. My first fantasy had been too impractical and the second, up to a point, too abstract. It occurred to me that the Animal Kingdom Ball might simply be a sociable coming together of famous biologists. Of course! This was to be a ball in honor of symbiosis, the productive relationship between man and beast, between biologist and his animal subjects. Unlike the usual convocations of biologists, however, this one would feature the presence of the *animals* as well as the biologists who studied them. George Schaller would certainly be there with a gorilla or two and possibly a tiger, reflecting more recent work in India. The ethologist Konrad Lorenz would be followed all around the dance floor by two imprinted goslings, and throughout the evening he would behave as though he were their mother; while, from overhead, a pair of jackdaws would occasionally, and in a friendly way, dive-bomb him. When they weren't dive-bombing, these jackdaws would undoubtedly engage in mild territorial squabbles with several of Darwin's finches, which would have arrived from the Galápagos in the company of the ornithologist David Lack. The aerial combat might turn out to be an annoyance to George Gaylord Simpson, the expert on the evolution of horses, who, by virtue of the fact that he would probably be astride a Przewalski's horse, would be operating in an unfamiliar and disputed altitude. Unfortunately, Archie Carr would send his regrets from the Caribbean, citing the proximity of the hotel kitchen and its carnivorous soup pot to that area of the ballroom assigned to him and his green turtles.

The insect people would cause the greatest apprehension. Imagine the unpleasantness if the bees brought by Karl von Frisch or the wasps brought by Howard Ensign Evans developed a sudden case of ill-temper. But, on the other hand Dame Miriam Rothschild, the world's greatest expert on fleas, undoubtedly could be depended on to keep her small charges well in hand (or somewhere). But once again I arrived at the limits of good taste. For what responsible organizer of animal kingdom balls could reasonably refrain from inviting the recently celebrated Desmond Morris? Yet, what would happen if Dr. Morris were to arrive on the scene with an unabashedly naked ape? Fantasy three went in the same direction as the others.

Thursday night arrived and I went to the Animal Kingdom Ball.

A few species were, indeed, represented. A squadron of plastic dogs and rabbits sat on a table and had rings tossed at them. You won five blue chips if you ringed one. A forlorn-looking stuffed dog, one of the gaming prizes, sat on a shelf. It remained unclaimed, a small irony since the proceeds of the evening were for the A.S.P.C.A.'s adoption care program. The real action began after some dancing—I did detect a foxtrot here and there—and just before dinner. With everyone comfortably seated and their bets securely placed, four horse races were projected on a motion picture screen. It seemed a trifle bizarre. For twenty minutes the ball was not a ball but an afternoon at Hialeah or Churchill Downs, and everyone cheered, whistled, and stamped as Number Five moved along the rail. The atmosphere was positively electric.

After more dancing, prizes were awarded. These consisted mostly of stock—not cattle or sheep, but solid, New York Stock Exchange stock, which carries a lot of weight in this city. Then the ball came to an end. It had been pleasant. It had been somewhat like a prom. It had made a lot of money for dogs and cats. But on the way home, I missed, a little, the peaceable dance of the animals, the taxonomic quadrille, and the society of celebrated symbionts. Perhaps the next fund-raising event held by the A.S.P.C.A. will excite my fantasies again. Every year they set up a small, temporary boutique in New York and call it The Ark.

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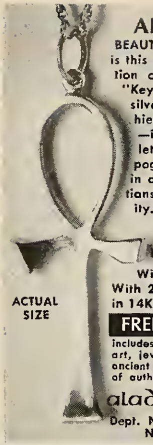

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City of the Prophecies—*Continued from page 24*

glass and electricity, forging forever up the dark river. (The Hudson—like a river of oil, filthy and rich, gleaming with silver lights.) Manhattan at twilight: floating gardens of tender neon, the lavender towers where each window glittered at sundown with reflected incandescence, where each crosstown street became at evening a gash of golden fire and the endless flow of the endless traffic on the West Side Highway resembled a luminous necklace strung round the island's shoulders.

Who would believe the city could be so beautiful? On winter evenings when the sun went down early and all the office lights stayed lit, the giant glass buildings across the river glowed like blocks of radium: a cool soft Venusian radiance, magnetic and fatal. And above them all stood the Vampire State Building with its twin beams stroking through the mist and the red spider eyes on the radio mast blinking slowly off and on, off and on, all through the New York night. While deep-sea liners bayed in the roadstead, coming up The Narrows, and tugboats shaped like old shoes and croaking like alligators glided by in the opposite direction, towing freight trains or barges filled with traprock. Once I saw a large dark ship, no visible running lights at all, pass between me and the clustered constellations of the city—a cloud moving across a field of stars.

One night Manhattan itself became that dark ship. Under moonlight the city appeared to be deserted, abandoned, empty as a graveyard except for the dim beams of automobiles groping through the blacked-out canyons, fumbling for the way home. From where I stood in Hoboken, on a hill above the waterfront, I could hear not the faintest sound of life, not a heartbeat, from New York. The silence was impressive. But by the next night the power was back and the city shining like a many colored vision of wealth and glory. From the little park in Weehawken where Aaron Burr shot Alexander Hamilton (good shot!) you could look right down the center line of 42nd Street. With glasses powerful enough you could watch the sports and pastimes of the folk who dwell in the City of Dreadful Night.

If the Lower East Side is now the East Village, Hoboken was (still is if urban renewal has not yet destroyed it all) the West Village. Down on River Street just past the gothic gables of the Christian Seamen's Home began our own little Bohemia, where the otherwise omnipresent odor of sewer gas, burning coffee beans and the Hudson River was sweetened by the smell of marijuana and smoking joss sticks. Under the black shells of condemned tenements lived the Peace People, the Flower Children, in happy polygamous squalor. Woven gods-eyes dangled from the ceilings; on once blank and dusty storefront windows appeared the American flag, hand-painted, with five, six, or seven stripes and anywhere from a dozen to twenty stars, asymmetrical as nebulae. The men had hair on their heads, beards on their jaws, and their old ladies were as slender, sweet and comely as their tresses were long. My friend Henry the painter was painting nothing but gas stations that year. Esso gas stations. And Rini the sculptor was busy welding and reworking junked auto parts into surreal hobgoblins of iron. "Look here Rini," I said to her, "instead of dragging the damned junkyard into the art galleries, why don't you throw the damned art galleries into the junkyard?" "That's exactly what we're doing," she replied. They had a coffeehouse—The Baby Bull—and nocturnal police raids and finally even a murder of their very own.

Hoboken may be the only city in America where some of the police were actually caught in the act of tampering with the voting machines: there was a resolution on the ballot in that election which if approved would have authorized a substantial pay increase for the fuzz and the firemen.

Which suggests the role of POWER again: When I lived in Hoboken the most densely populated, square-mile city in the U.S. seemed to be inhabited largely by babies; you could not walk down the main drag, Washington Street, at any time during daylight hours without being compelled to thread your way through traffic jams of loaded baby carriages, many of them containing twins, some triplets, each carriage powered by a pregnant mother with vo or three toddlers dragging at her kirts.

The character of this population f mothers and children was mixed, typical American polyglot boiling ot of Italians, Irish, Puerto Ricans, oles, Jews, Germans, and Negroes. ut there could be little doubt as to hich *ethnos* still dominated the visile structure of authority when you ead in the local paper of the latest athering of dignitaries at the Union lub: present were *Mayor Grogan*, *ouncilman Hogan*, *Bishops Malarey* and *Moone*, *Commissioners loyle* and *Coyle* and *Boyle*.

But who were those others we ometimes had a glimpse of on rare nannounced occasions, heavy short warthy men with Homburg hats, elvet-collared overcoats, fat cigars, unk far back in the corners of black imousines which glided swiftly uietly (no sound but the hiss of rubber on greasy asphalt) down the vening streets? Who were those two Iongolian wrestlers dressed like CID peratives, one driving, one scanning he sidewalks with stonefish eyes?

Hoboken. Weehawken. Hohokus. ecaucus. Paramus. Manhattan. And he five boroughs of New York. True, ve were separated by a river from the enter of the city. But are not the thers also cut off by water? The Iarlem River. The East River. What s the Brooklyn Bridge for? What is he function of the Staten Island erry? New York is a city of waters nd islands, like Venice, floating on ewer lagoons under a sea of fog and moke and drizzling acid mists. You ave to be tough to live there—even he clams on the offshore shelf are ull of polluted pride. The chickalees, starlings, sparrows and alley ats of Hoboken were a hardier neaner breed than you find elsewhere. The old trees in the little arks along Boulevard East and Hudson Street seemed lifeless as tatuary most of the year; yet in April there came an astonishing outburst of delicate green along the ength of those blackened limbs. As f leaves should grow upon gun barels and—but why not?—bright fuzzy weeds spring up from the mouths of annon.

I suppose I liked best the sunflowers along the railroad tracks. Little ourple asters that sprouted up between the ties, out of the cinders. The attails in the ditches and the rank nameless weeds that flourished by the

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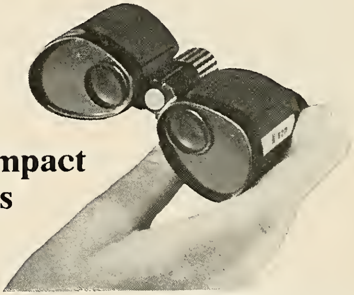

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iron wheels of rotting ancient wooden boxcars—*Erie-Lackawanna—The Great White Way—Route of the Phoebe Snow*—forgotten on sidings. The feral hollyhocks along the walls of the gate tender's shack at the railway crossing, transpiring in July, tall as corn. There was a bitter forlorn yet stubborn beauty everywhere you looked in Hoboken. Even the smog of heavy summer evenings played a helpful part in the quality of light and shadow on old brick walls, lending to things only a block away the semblance of magic and mystery.

When I was there I thought New York was dying. Maybe it really is. I know that I was dying to get out. But if it's dying then it's going to be a prolonged and rich and strange and infinitely complex process, a death of terror and grandeur. Imagine a carcinoma three hundred miles long, a mile thick, embracing fifty million souls. Whatever else (I tell myself) you might think about New York now, looking back at it from this desert perspective, you've got to admit that Lukeville, Arizona, does not have four million women.

There are three ways to get from Hoboken to Manhattan. There were four. You can take the #6 bus, dive into the Lincoln Tunnel (holding your breath), roar through that tube of tile and light that looks like nothing so much as the world's biggest public john, where the tunnel cops pace forever up and down their cement walkways or stand in glass boxes built into the walls (we used to discuss what was the world's worst job: subway motorman? city bus driver? slaughterhouse worker? switchboard operator? or tunnel cop? those nightmare existences . . . .) and emerge suddenly into the blue and carbon monoxide laden air of the Port Authority Bus Terminal. Or you could take the Hudson Tubes under the river, ride the trains through the dark sweating tunnels, where little green lights blinked dimly beside the rails, and come out in the Village or stay on the train and ride it uptown as far as Macy's, Gimbel's, Herald Square. The third way, if you have a car, is to drive it yourself through either the Lincoln Tunnel or the Holland Tunnel and drive it back through the other when you realize finally that there is no place on all of God's Manhattan where you can park your machine.

The fourth way was to take the Lackawanna ferry and although the slowest this was of course the best. (A fifth way will be to walk on the water as the Hudson gradually, inevitably coagulates.) Getting to the ferry slips at the railway terminal was part of the pleasure: for whether you went by Washington Street, Hudson Street or River Street you passed not only such places as the hippie communes and the Christian Seamen's Home but also more shabby dingy rundown smelly unlighted dangerous and irresistible bars than a man could count and patronize.

It was said, not without good authority, that Hoboken had more bars per square block than any other city in the world except Anchorage, Alaska, and I believe it. I never did get into all of them though for two years I tried. Some of them I remember: The Old Empire, The Seven Seas, Allie and Jopie's, Anna Lee's, Portview, El Jim's, The Dutch Mill, The Elysian Fields Bar & Grill, The River Street, The Cherokee, The Old Holland House, McSharry's Irish House, The Continental, The Little Dipsy Doodle, The Grand, The Inn, The Idle Hours (how true), Pat's, Pete's, Lou's, Joe's, and Mom's. And The Silver Trail, Hoboken's only genuine Western bar, with live Western music and authentic cowboy stomp dancing every Saturday night; and Nelson's Marine Bar, my favorite, whose only bartender, Herman Nelson, sole owner and proprietor, is or was the man who *almost* became world welterweight champ in 1931; and the bar of the Clam Broth House, standing room only, free clam broth, Löwenbrau on tap, the crackle of clamshells underfoot.

Anyway, if you made it past all the bars and the three Chinese laundries—Sam Toy's, Harry Lew's, Gong Lee's—the hash peddlers and the cops and the Christian seamen and the bohemes and the whores and the bums, panhandlers, winos, shoeshine boys, and shiv artists, you arrived at the Erie-Lackawanna Building. End of the line. Mouth of the Tubes. Home of the ferryboats. The E-L Building (is it still there?) looked like a square fruitcake coated with green mold. It was enormous, a cavernous interior with capacity for a dozen trains, the boats, the shops and offices and waiting rooms, the multitudes of hustling men, Manhattan officeworkers in brown, gray, black, transferring from the surface trains to tubes or ferries.

All on board, gangplanks winched up, the rattle of chains now stilled, the boat surged powerfully out of the slip and bore east southeast across the Hudson toward the Barclay Street docks on the far side. Moving partly with the current and partly athwart it, the ferry traced a graceful parabolic curve as it churned from shore to shore. In winter we glided among drifting ice floes the color of urine; in summer through trails of garbage bobbing in the wake of ships, seagulls screaming as they wheeled and dove for supper. I liked to stand on the open forward deck facing the wind and the tall solemn monuments of lower Manhattan. For a few minutes at least we were all free, commuters, drifters and students alike, liberated from the confines of lubberly life and at home—so we thought—with sailors and seabirds, the allure of the open sea. It seemed to me that I could read on the faces of even the most resigned commuters, the mild and melancholy heroes of the nine to five, the sad soft shaved salaried slobs who looked as if they'd been *born* playing money games in the portals of their mothers' wombs, even on their faces I could see it, what I felt: elation.

It was strange, that approach to Manhattan over the open water. No sound but the slap of waves, the wind, the gulls, the distant signals of other boats. The city itself swung slowly toward us silent as a dream. No sign of life but puffs of steam from skyscraper chimneys, the motion of the traffic, at evening the lights. The mighty towers stood like tombstones in a graveyard, leaning against the sky in perfect parallel perspective. (All but one—that new box of glass and aluminum erected by the Chase Manhattan Bank, it alone seemed out of plumb with the others, as if one corner had sunk a little.)

And then as we came close we began to hear the murmur of the city's life, the growing and compelling roar, the sound of madness. Newspapers were folded, overcoats buttoned, hatbrims tugged—those gray near-brimless little felt hats which all the men wore and which had the peculiar virtue of rendering the wearer invisible—as everyone crowded toward the front of the boat. You could see the tension stealing

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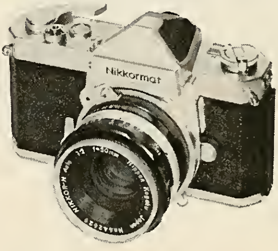

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over each face as two hundred full-grown men prepared themselves for the stampede to the subway trains. The spectacle of a man running to catch a train embarrassed me; I shared somehow in his humiliation, I had to avert my face.

But those were the mornings. Mornings were always absurd and desperate in New York. In the evening, going to the city, of course the mood was different, only a few of us on the boat, going the wrong way—the right way—against the mainstream of human traffic. In the evening the great glittering ship of Manhattan seemed to promise the fulfillment of every desire, every wish; one sailed toward it through the purple twilight with a heart full of hope. Hope for what? Hard to say—hope for those things which a man desires so much he hesitates to name them: for love; for adventure; for revelation. All of it seemed to be waiting there in that golden city of electric glory which rode and would ride forever—I told myself—upstream on the rich black oil of the Hudson. All of it almost within reach.

That was the view from the water, the fantasy of the river crossing. Close by, the scene came into a different focus; we found ourselves again back in the profane world of people with problems, embittered cab drivers, Sam Schwartz and his roasted chestnuts, the quiet tragedy of human relationships. No amount of pot or booze or sex or art could permanently alter any of that. Something quite different was required.

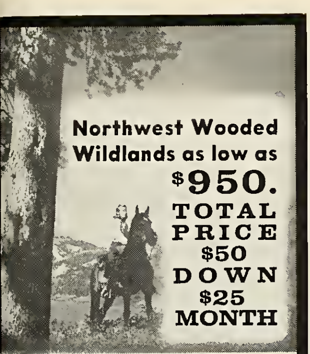
I was a walker. I always walked from Barclay Street up to the Village, preferring the grim and empty downtown streets to the infernal racket and doomed damned faces of the subway. Pausing at the White Horse for a drink to the memory of Dylan—the one from Cardigan Bay—and thence to Dillon's where I *might* meet somebody I knew, and from there to the Cedars, international intersection of all Volkswagen Bohemia where I *always* met somebody I knew, where anybody meets somebody, we threw a few back while deciding whose opening, whose screening, whose party to crash on this wild, full-of-wonder high-blossoming night.

After a quick trip to the john to memorize the newest writing on the wall—Socrates Loves Alcibiades; Joy Shipmates Joy!; Here I Sit Anonymous As Hieronymous Bosch; Caligula Come Back; Mene Mene Tekel—it was out on the jam-packed streets again, in and out of a cab and up a tunnel of stairways into somebody's loft—THIS FLOOR WILL SAFELY SUSTAIN A LOAD OF 70 LBS. PER SQUARE FOOT—and into The Party.

The Party was permanent, like the revolution, always in swing somewhere, with the same conglutinate crowd, the same faces, the same wilted potato chips, the same red wine, the same dense atmosphere of smoke and heat and intellection, the same blonde lovely girls down from Boston for the weekend, the same paintings of Esso gas stations on the walls, the same raccoon-eyed lank-haired crepe-clad pale-faced vampire lass hesitating in the doorway, to whom some catty chick would say, "Well do creep in." Norman Mailer was always there, a glass in each hand, and Dwight MacDonald, and the poet Joel Oppenheimer, and the man who invented Happenings, I forget his name. Everyone was there in fact but the host, who usually slipped out around midnight.

There were other parts of the town I got to know, a little. For a while I had a girl friend who lived on 14th Street, near Union Square; I worked as a technical writer for General Electric in an office building on Lower Broadway, editing training manuals on how to dispose of sewage in permafrost, under Arctic conditions; we all had to wear white shirts, that was mandatory, and I was fired at the end of two weeks for spending too much time staring out the window. I was invited a few times to publishers' offices in the midtown region, to an agent's office in Rockefeller Center, to lunches at Sardi's. My wife had an M.D. with an office in the East 60's. Once I went to Wilt Chamberlain's nightclub in Harlem. And I worked for a time as a welfare caseworker in the Atlantic Avenue district of Brooklyn—but that is another story, that was another world, that was lower Mississippi we were dealing with there, let us now praise famous men. But I lived in Hoboken.

The Party is over, for me. In the gray light of dawn with the Sunday *Times,* world's most preposterous



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newspaper—all those dying trees!—rolled under my arm, I navigated the deserted streets. Bleak and God-forsaken Sunday. Down into the subway entrance, down into the dim calamitous light of the Tubes. Into an empty car. The placards on the walls: GIVE: multiple sclerosis; muscular dystrophy; heart disease; cancer; mental illness; nephritis; hepatitis; venereal; cerebral palsy; TB; leukemia. (Must surely be the sickest city in the world.) Buy Bonds: Keep Freedom In Your Future. Good God. The train jolts forward, begins to move; the dripping steam pipes, the little blue lights, the sweating walls slide greasily by. Just a happy little journey through Hell. Other slogans come to mind: Business Means America; America Means Business. This Is Your Country—Love It or Leave It. The train paused at the Christopher Street station. Before it moved on again I had a glimpse of a pair of rubber gloves lying in a pool of grease beside the tracks.

We plunged beneath the river. I slept all day. At evening I walked once more along the waterfront and gazed across the water at the somber forms of Manhattan, the great towers largely dark, for on Sunday no one is at work over there but the janitors. What has all this to do with natural history? This: it may soon be all the natural history we've got. I don't know how New York can survive.

I believe the city is doomed. The air is so poisonous, not merely with filth and disease but with something deadlier—human hatred. Yes, there's hatred in Lukeville, Arizona, too, but here it is easily dissipated into the nothingness of space: walk one half mile away from the town, away from the road, and you find yourself suddenly absolutely alone, under the sun, under the moon, under the stars, within the terrible and aching loneliness of the desert.

But that loneliness is not enough; which is why, somehow, we must save the city. It is essence and substance of us all—we cannot lose it without diminishing our stature as a nation, without a fatal wound.

My words therefore are dedicated to that city which we love, that visionary city of the prophecies, humane and generous, that city of gentleness and beauty and joy, which may come to be, someday, on American earth, on the shore of the sea.

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Books in Review

Bird Watching—An Abiding Avocation

by Robert Cushman Murphy

Interest in birds is an incurable malady, likely to strike an individual at any age and to remain ever after an enriching avocation. *Amor, ch'al cor gentil ratto s'apprende*—"love,which seizes quickly on a high-born heart"—sang Dante, the Florentine poet, seven centuries ago, and indeed there is a resemblance between falling in love and the moving relationship that first makes one truly *aware* of birds. To a lady with whom I have had a very long acquaintance, it happened on a May morning more than fifty years ago, when a flock of red crossbills alighted in a small pine while she was virtually enclosed among the branches. There they were, perching within inches of her face and arms, devoid of fear—as many of the boreal finches are apt to be —and in no hurry to leave. My wife has never recovered from the magic intimacy of her first meeting with crossbills.

To the British writer, W. H. Hudson, enlightenment came, on the other hand, like a thunderbolt of Olympian Zeus. A collector in Argentina for the British Museum, he shot and mortally wounded a bird, which a moment later burst into song in his hands. This proved so overwhelming that it changed Hudson's whole personality. He never throughout his long life fired a gun again. Echoes of the incident, in which he makes no distinction in brutality between shooting for sport and for the increase of knowledge, appeared decades later in *Green Mansions.*

Those who become entranced by birds in childhood make their own way through association with like-minded friends. They eventually join a bird club, such as the Linnaean Society, and progress naturally through a gamut of bird books. It is chiefly those in whom the taste is deferred that require such counsel as I am here giving. Mature persons quickly realize that birds do astonishing, even wonderful, things, and curiosity about the why and wherefore follows quickly after the ability to recognize them.

Beginning bird watchers are moved by a desire to know what they are looking at. Therefore their first need is a manual of identification, preferably of a size to fit in pocket or handbag. There is today a wide choice of these, but nobody can go wrong with Roger Tory Peterson's *A Field Guide to the Birds* or its equivalent, *A Field Guide to Western Birds.* If you are bound abroad, *A Field Guide to the Birds of Britain and Europe*, by the same author and two Old World colleagues, is the book to take along. It will cover any birds you are likely to see—from the countries of the North Atlantic, across continental Europe, to the Ural Mountains and the Levant.

The principle of the Peterson Guides, which was his own "invention," is to replace description by *diagnosis*, i.e., to stress the one or more characters of plumage, posture, or even voice by which a species differs from all others. This is accomplished partly by arrows pointing to the diagnostic feature in the faithful and practical drawings with which all Peterson books are abundantly supplied.

A very handy newcomer in the recognition of birds is *Birds of North America: A Guide to Field Identification*, b Robbins, Bruun, and Zim, with colore figures of every species by Arthu Singer. This remarkably compact vo ume also includes a surprising amour of pertinent text, a small map showin the distribution of every bird, a son gram of the voices of many, and mon chrome silhouettes across the top of th color plates showing conformation an poses of species likely to be confuse with birds in the larger portraits. Th ingenious work, published by th Golden Press, New York, is availabl in paperback as well as hard-cover.

The habits of our own birds are e haustively discussed by Arthur Clev land Bent in *Life Histories of Nort American Birds*, published by th Smithsonian Institution in twenty vo umes between 1919 and 1958. Althoug many of the originals are now hard t purchase, they may be found in mo lending libraries; moreover, the vo umes are now being republished by th Dover Press. Bent devoted forty yea of his life to the task, and summarize the findings of nearly every America ornithologist from Wilson and Audu bon to many persons who still live. T read Bent is to follow the opening of continent by settlers from more ancie lands and, alas, to realize the devast tion that they inflicted within three ce turies upon the habitat and fauna the New World.

Bent's great record refers for th most part to the preexperimental p riod of ornithology, which began—s far as bird lovers in general are co cerned—with the publication of H. Howard's *Territory in Bird Li*

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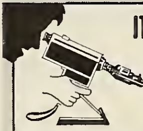

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(1920), a book that is still required reading. It opened a wholly new era of research into the stimuli of behavior and demonstrated that many actions had been previously interpreted in anthropomorphic terms that really explained nothing. The literature of bird psychology, or behavior in its essential meaning, has seen an enormous development since Howard and has claimed the attention of very eminent men of science. A notable example of this rigidly scientific approach is Mrs. Margaret M. Nice's *Studies in the Life History of the Song Sparrow*, published in the *Transactions of the Linnaean Society of New York*, in 1937 and 1943. Other research, treated with more intent toward entertainment, is that of Dr. Konrad Lorenz, as he told of his rooks and geese in *King Solomon's Ring* and *The Companion in the Bird's World*, which first appeared in the *Auk* in 1937. He deals among other matters with the strange phenomenon of "imprinting," by which certain birds, shortly after hatching, can be induced to accept a human being as their "mother," a fixation that endures throughout life.

We know now that "common sense" may lead us far astray in the interpretation of bird behavior. Unlike man, birds are highly instinctual creatures. Their brains have neither a convoluted cortex nor gray matter. Such "thinking" as they do is carried out in a primitive part of the brain stem known as the *corpus striatum*. They have marvelous sense organs and perhaps unequaled awareness of their surroundings, but are endowed with less "intelligence" than mammals regarded as low in the scale of evolution.

A few examples may serve to illustrate. A flicker normally lays five to seven eggs in a tree-trunk cavity. If, however, one of two eggs is removed each day by an experimenter, the bird may continue to deposit an egg a day for forty days or longer! Weaverbirds tie the ancestral knots in nest building, even though they are hatched in an incubator and have never known a parent. On the other hand, they may attempt to sing the song of any strange species that they hear. Song is learned behavior, whereas the making of a nest is instinctive, although capable of improvement with experience. Another interesting discovery of the age of experiment is the hierarchy of social precedence among gregarious birds, as expressed by the pecking order. It shows that snobbery is much older than man!

Works that I have found particularly valuable in this fascinating field include *Bird Display and Behaviour*, by Edward A. Armstrong (1947), *The Herring Gull's World*, by Niko Tinbergen (1953), and especially the monumental work *A New Dictionary o* *Birds* (1964), edited by Sir A. Lands borough Thomson and published b the British Ornithologists' Union. I must be admitted that the behaviora concept has become more and more part of nearly all books about bird with the passage of time. Thus Willian Beebe's *The Bird: Its Form and Func tion*, published 62 years ago and still a extremely informing book, has little t say about even such important matter as migration and homing, whereas suc recent books as the following reflec the new emphasis in ornithological sci ence: *The Bird: Its Life and Structur* (1951), by Gertrude Hess; *The Bird* (1958), by Oskar and Katharina Hein roth; *Bird* (1962), by Lois and Loui Darling; *The Birds* (1963), by Roge Tory Peterson and the Editors of *Life* *Birds of the World* (1964), by Pau Barruel; *Biology of Birds* (1963), b my colleague Wesley E. Lanyon.

For a record of birds ever since ma has been observing them *A History o* *Birds* (1954), by James Fisher, is a excellent brief text, with a bibliog raphy that opens windows for the seri ously interested reader. And for a his tory covering millions of years, an telling of the probable reptiles fron which birds have descended, *The Ori gin of Birds* (1927), by Gerhard Heil man, is still the best available study i English.

The number of books about birds i all languages is now believed to excee a hundred thousand, and most of thes have been published within the presen century. This makes selection arbitrar or chiefly a matter of highly persona opinion based, at best, on fragmentar knowledge. There are books on natura groups, such as families or orders o birds; books on the birds of geograph ic areas as large as a continent or a ocean or as small as a dooryard; book dealing with a single avian attribute such as flight; books aimed at factua explanation; and books written with n other purpose than to convey some hin of the charm that birds have alway had for mankind. As our late chief, Dr Frank M. Chapman put it, "Birds ar nature's most eloquent expression o beauty, joy, and freedom." Withou meaning to limit the purpose of the respective authors, I may say that thre of my favorites in the latter categor are the chapter on waterfowl in Viscount Grey's *Fallodon Papers* (1926) Lord William Percy's *Three Studies i* *Bird Character* (1952), and Eleanor R Pettingill's *Penguin Summer* (1960).

To conclude, I must add a word about two of the greatest bird book ever written, namely, *The Dictionary o* *Birds* (1896), by Alfred Newton, wit assistance and contributions from onl four associates, and the previousl

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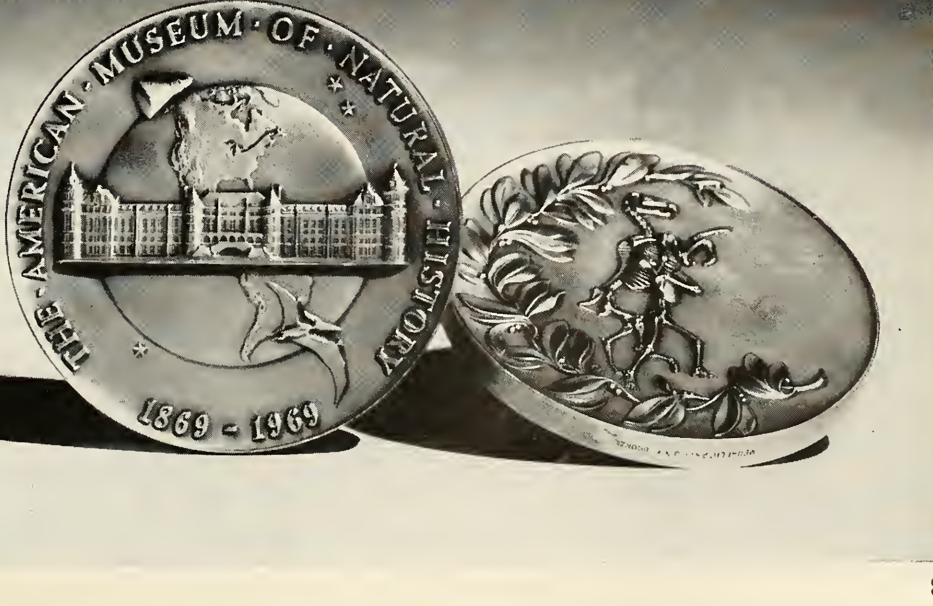

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mentioned *A New Dictionary of Birds*, in which the editor and principal author enjoyed the collaboration of more than two hundred of the world's foremost ornithologists, photographers, and artists. Each massive volume pertains to its age: Newton's from the lore of antiquity to a time when Darwinism was beginning to be well entrenched in worldwide thought; Thomson's to the peaks of contemporary scientific discovery. Neither book is as well known as it ought to be to present-day birdlovers, who would find both of them illuminating and delightful reading.

Dr. Murphy is Lamont Curator Emeritus of Birds at The American Museum.

TIBET, by Thubten Jigme Norbu and Colin M. Turnbull. *Simon and Schuster, $7.50; 352 pp., illus.*

This book is the work of two persons: Colin M. Turnbull, an anthropologist, and Thubten Jigme Norbu, elder brother of the Dalai Lama, and himself the twenty-fourth reincarnation of a fifteenth-century monk and former abbot of Kumbum monastery, now living in the United States. The book aims at giving an image of Tibet as seen and understood by a Tibetan. In its organization it combines a chronological sequence of Tibetan history with the personal experiences of the Tibetan author that relate to or explain events of the past. An opening account of the origin of the world according to Tibetan belief is followed by a description of the country and its people, with special attention to the peasants and nomads of the northeast—the country of the Tibetan author—and to the city of Lhasa. The historical account then begins with the first period of Tibetan history before the arrival of Buddhism and includes a description of the modern form of the non-Buddhist Bon religion. When the historical account deals with periods during which the Gelukpa "sect" prevailed, the personal experiences of the author become more pertinent: his and his brother's recognitions as reincarnations, the use of oracles, and the monastic education of the author are woven into the historical narrative. In this way the book achieves its aim of presenting Tibet's history as seen by a Tibetan, the cultural background for each major period is provided, and a feeling of living history is conveyed.

The presentation is obviously suitable for popular consumption, but it is not devoid of scholarly value and one wishes a more scholarly apparatus had been provided. A glossary and an index will be missed by anyone nee ing to remember who or what a pa ticular person or institution is, as we as by those who want to learn about topic that may have been discussed different points within the historic narrative. Since this is history as see by a modern Tibetan, one would al like to have a better account of the ed cation in history that is normally give to a Tibetan monk. We may assun that Mr. Norbu did not learn in Tib about the philosophy of Bishop Berkley, but what about his knowledge Catholic missionaries in Lhasa durin the eighteenth century? How much d modern Tibetans know about it, and d they read Fr. Desideri who is quote in this section?

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Perhaps this is asking too much, fc we are told in the introduction th this book "is not an account for ac demics who are concerned only wit lesser, petty forms of truth; it is fo dreamers, for people with souls, wh are concerned with a larger truth. This avowed aim of the book demand some critical comments.

In case the reader cannot dream hi own larger truth, he is helped along i a number of passages. For instance, i a discussion of the Sixth Dalai Lama sexual escapades, we are told that "i we look for goodness, we can find anywhere and everywhere and there i nothing in this world that cannot b turned to our advantage and made t help keep us to the Middle Path." I the Sixth Dalai Lama, then, could fin his goodness in whoremongering, pe haps soulless academics should be a lowed to search for enlightenment i their lesser, petty forms of truth. Fo this, in fact, the book under review wil provide material. For instance, an illus tration section includes a number o drawings by Lobsan Tendzin showin female costumes from various prov inces, the hats worn by different monk and religious leaders of the past, an most illustrative drawings of nomads tents and their content. These illustra ions will appeal to those interested in details of material culture, but while charming, they do not seem to this reviewer to reveal any larger truth.

As to the class structure and political system, the authors say: "It is important to realize how little we care or the life of the nobility, for it is often alleged that we are abused by them. The only people they can abuse are themselves. The rest of us are content to leave the problems of politics and economics to those whose jobs they are, being thankful they are not ours." This describes well the authors' outlook and reflects the traditional status of Tibet as a religious state under the patronage of the Chinese emperors. It is doubtful that social scientists will take this as a larger truth, but perhaps they will agree with another of the authors' pronouncements: "The truth is one, no matter how we look at it, and most of us can see no more than a small part of that truth. Ignorance lies in thinking that we see it all."

PEDRO CARRASCO
State University of New York
at Stony Brook

Briefly Noted:

SEASHELLS OF NORTH AMERICA: A GUIDE TO FIELD IDENTIFICATION, by R. Tucker Abbott. *Golden Press, $3.95; 280 pp., illus.*

An addition to the generally excellent "Golden Field Guide" series is this comprehensive study of North American seashells. The author, Chairman of the Department of Mollusks at the Academy of Natural Sciences of Philadelphia, covers more than 850 species of common shells of the Atlantic and Pacific coasts. Biological information is provided, along with special sections on the collection, identification, and preservation of mollusks. The more than one thousand full-color illustrations were done by George Sandstrom.

BIRD GUIDE OF THAILAND, by Dr. Boonsong Lekagul. *The Association for the Conservation of Wildlife, Bangkok, 271 pp., illus.*

Dr. Boonsong Lekagul, a physician with a long-standing interest in birds, has produced a beautiful little volume, *Bird Guide of Thailand.* Intended for use in the field, the book is light weight, has brief, descriptive texts, and is fully illustrated with Dr. Lekagul's delicate paintings. Published in Bangkok, this guide may be purchased from Pierce Book Company, Winthrop, Iowa 50682, for $8.50.

SNAKES: THE KEEPER AND THE KEPT, by Carl Kauffeld. *Doubleday & Co., $5.95; 248 pp., illus.*

This book should prove invaluable to those who wish to keep snakes, either as pets or as part of home or school collections. While a good part of the text is devoted to the fundamentals of snake keeping, Carl Kauffeld, who is Director and Curator of Reptiles at the Staten Island Zoo, has collected forty years worth of anecdotes on his snake-hunting experiences, and these are liberally sprinkled throughout the text. The book is both entertaining reading and an excellent reference.

C. B.

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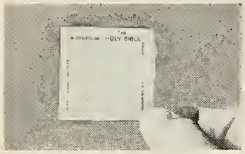

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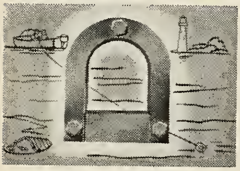

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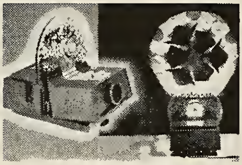

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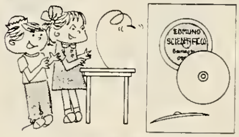
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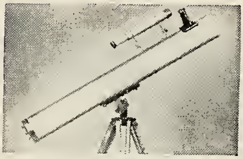

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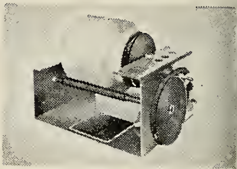

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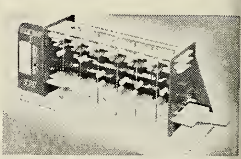

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A CONEY ISLAND OF THE MIND. L. Ferlinghetti. New Directions, San Francisco, 1960.

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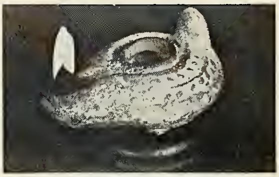

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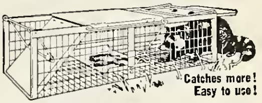
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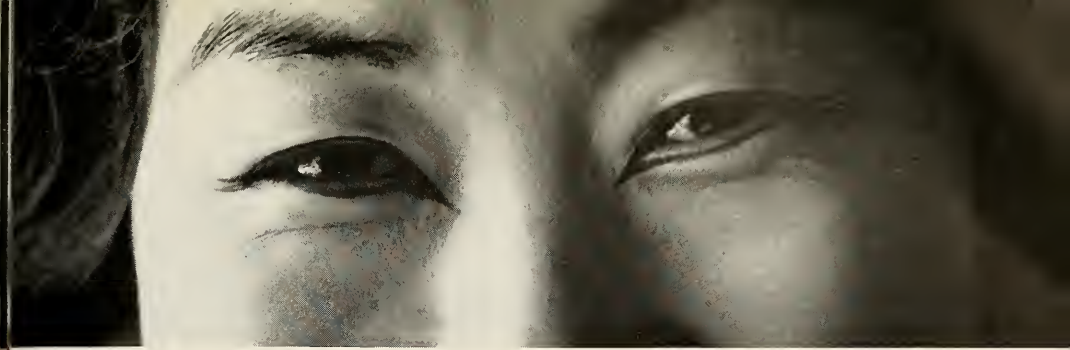

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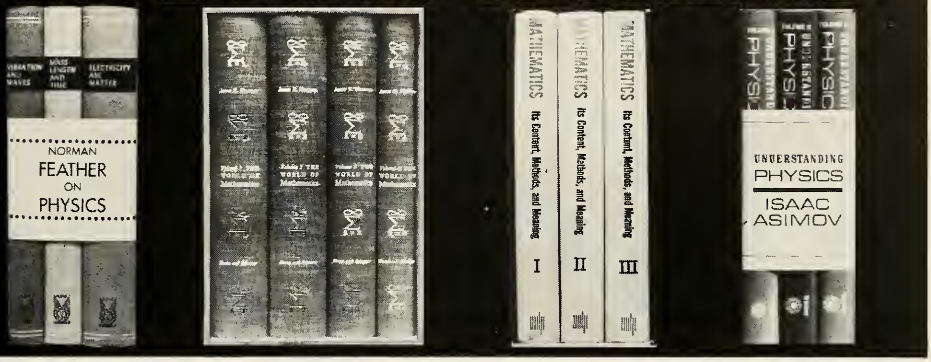
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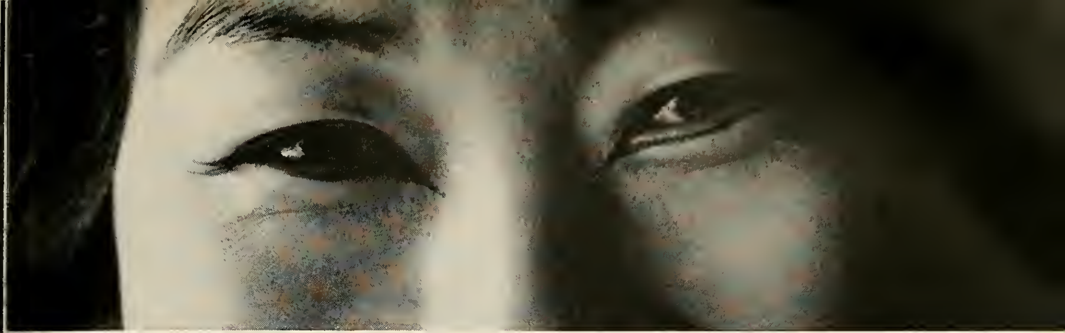

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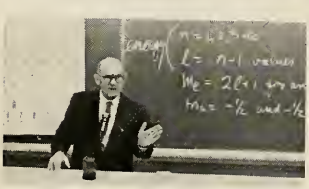
THE AUTHORS

An interest in the discarded theories of science, and what they can tell us about the nature of man, led **Dr. Mark Graubard** to a study of astrology. Chairman of the Natural Science Program at the University of Minnesota. Dr. Graubard is the author of fourteen technical papers on skin pigment. His primary interest, however, has been the history and evolution of science, and he has assembled the largest collection in America of ancient scientific instruments. including water clocks, gnomons, and armillary and planimetric astrolabes. Dr. Graubard is also the author of a novel. *In the Clutches of Homo and Sapience.*

As part of his research into the artistic origins of the Persian Empire. **Bernard Goldman** has traveled thousands of miles in the past eighteen years. locating and cataloging the fragmented pieces of the "Treasure of Ziwiyeh." Similar in style to the artistic tradition exhibited by the ancient ruins of Persepolis—which he studied last year—the treasure offers clues to the origin of Persian art. Dr. Goldman, author of *The Sacred Portal,* is assistant editor of the *American Journal of Aesthetics and Art Criticism.*


Mark Graubard

"The Royal Fleece of the Andes" is the result of **Nancy Flowers'** recent trip to a Peruvian vicuña ranch. A free-lance writer and photographer, Miss Flowers was raised in Portugal and has traveled extensively since then, particularly in Latin America. She has contributed two previous articles to Natural History—"Majestic Workboats of a Portuguese Lagoon" (February, 1965) and "Pottery of Barcelos" (June, 1966). Miss Flowers is now returning to Colombia to complete a book about an Amazon Indian child.

"A bit of a dream, a portion of persistence. and an unknown quantity of luck" began **John P. Milton's** expedition through the Arctic Wildlife Range in Alaska. His involvement with the natural environment has taken Mr. Milton through most of the American continent, parts of Africa, and Europe. The author of numerous books relating to natural resources, he now plans to develop a book series celebrating the earth's "wild places" and a group of tele sion programs on our present e logical situation. Mr. Milton is he of the Office of International Affa of The Conservation Foundation.

During his thirty-three years as biologist with the U. S. Fish a Wildlife Service of the Departme of the Interior, **Victor B. Scheff** encountered all kinds of species, cluding superfleas and mounta beavers, the subjects of his artic Dr. Scheffer, who earned the Disti guished Service Award in 1965, h taught Forest Wildlife Ecology a Natural History of Vertebrates at t University of Washington. He is al the author of several books, inclu ing *Seals, Sea Lions, and Walruse* published by Stanford Universi Press.

John H. Welsh is the author the article on mussels. Now Profe sor of Zoology Emeritus, Dr. Wels has been associated with Harvar University since he received h Ph.D. there in 1929. The author numerous scholarly papers on com parative neurophysiology, sense o gans, and behavior, Dr. Welsh ha done field work in Cuba, Panama Brazil, and at the Bermuda Biologi cal Research Station. Dr. Welsh, wh was raised in rural Maine, still en joys farming.

This month's "Naturalist a Large," **William A. Watkins**, is Research Associate at the Wood Hole Oceanographic Institution. A a bioacoustician, he has sailed all the world's oceans, from New Zealand and the Antarctic to the southern Chilean Islands, and is presently in Madagascar, recording the sounds of whales, porpoises, and seals. Mr. Watkins is interested in cultural anthropology—particularly the study of acculturation and languages.

For several years, **Frances Hamerstrom**, an ornithologist interested in predatory birds, has kept a journal on the behavior of her adopted Golden Eagle; her article this month is based on these recorded observations. A biologist with the Wisconsin Department of Natural Resources. and a past president of the Wisconsin Society for Ornithology, Mrs. Hamerstrom is the author of sixteen articles on birds of prey.

Bernard Goldman

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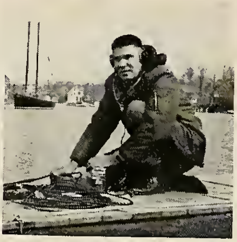
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Letters to the Editors

On the Peaceful Atom

I am writing you a mild letter of protest as pertains to the article, "The Myth of the Peaceful Atom," in the March, 1969, issue of NATURAL HISTORY. I have been for many years an associate member and subscriber to NATURAL HISTORY.

My objection to the article is that it is not objective. It falls in the same category as *The Silent Spring*. It is obviously a one-sided presentation—and a sensational presentation—with the objective of developing a sensational book that will sell.

It is interesting that the article opens with a quotation from, and reference to, Senator Thruston B. Morton of Kentucky. Without questioning Senator Morton's sincerity, it is rather obvious that he represented a state that is a major coal producer and that he might be reflecting the views of some of his powerful constituents.

As a businessman, I am aware that when we have an objective the problem is usually choosing between alternate methods of achieving that objective. The objective is to supply needed electrical energy for our expanding population and expanding economy. For practical purposes, the choice lies between fossil fuel and atomic energy sources. There are alternate sources, of course, beyond these two. There is geothermal, which is of economic significance in certain areas as in Italy and Alaska; there is tidal power, which may sometimes be harnessed in very special situations as on isolated ranches or islands of low population; wind and solar energy may have limited applicability. Still, when we go through the whole list, we must come back to a choice between fossil fuels and nuclear energy when we are speaking of the United States. Of course, in the past, water power has been of significance; but within the continental United States it has been developed nearly to the limit of its practical application and further steps, as in the Grand Canyon, would have significant ecological reverberations and would destroy our few remaining wilderness areas. On the Columbia River where power has been developed, it has had rather serious ecological consequences as regards fish population . . . specifically salmon.

In a preliminary consideration of human lives, we must remember that no member of the public, at the time this letter was dictated, has ever been harmed by the operation of a nuclear-powered generation plant, and as much cannot be said for coal mines that produce the energy for fossil fuel plants.

We should seriously consider the possibility of poisoning of the atmosphere by or through the operations of nuclear plants. Against this, we should consider the very known and real contamination of the atmosphere by combustion and products discharged into the atmosphere by plants burning fossil fuels. We should look at the incidence of lung cancer in metropolitan areas, compared to its incidence in rural areas and weigh how much of the difference is attributable to poisoning of the atmosphere from conventional fossil fuel plants.

Of course, when I deal with specific problems with which I am familiar—I have been a Member of the Board of Consumers Public Power District for the past twelve years and my father was on the Board for ten years preceding—I am on relatively safe ground. Consumers Public Power District built the Hallam Nuclear Plant, which is referred to in your article. The article does not state, as it should in fairness, that Consumers developed the Sheldon Station at Hallam as an experimental operation upon invitation by the Atomic Energy Commission. It does not state that one of the purposes was to determine the efficiency of sodium as a coolant. It does not state that though the efficiency of Sheldon Station was greater than other reactor systems, the small capacity of the installation would not permit it to be economically competitive with other sources of power. When, during routine operation, a need developed for rather extensive repairs, it was simply not economically feasible for Consumers to make those repairs because of the small size; nor for the Atomic Energy Commission to make those repairs because it had obtained much of the research and development information it needed. As a result, operation of the facility was discontinued and Consumers was reimbursed by the Atomic Energy Commission. More importantly, Sheldon Station demonstrated that sodium was an excellent coolant for large plants and could be handled easily by utility operators. This fact needed to be assured prior to the development of breeder-reactor systems that need sodium as a coolant. These breeder reactors, currently projected for economic feasibility in the early 1980's, produce more fuel than is consumed as the system produces electric energy. Without this development, future generations will face serious energy deficiencies.

Now, let us turn to the Cooper Nuclear Station with which I have some familiarity. This station site was chosen because of a very low population density. In fairness, it should be stated so and was not in the article. Of course, it is not advisable to locate either an atomic energy plant or a fossil fuel plant on a trout stream. But when the Cooper Nuclear Station is located on the Missouri River, when it is engineered so that thermocontamination will not raise the temperature of the Missouri River near point of entry as much as one percent, when it is realized that the Missouri River is the natural home of catfish whose optimum water temperature is above 60° F., and that the coarse fish in the river are not affected by a slight temperature raise; it can be seen that the ecological damages have been minimized, and in some cases ecological conditions improved.

There is a slow and steady development of industry in the heartland by which, according to my terminology, I mean the areas adjacent to the Missouri River. As a prime example, in Nebraska we have no coal. Coal is competitive with nuclear energy when the coal can be consumed at the mine mouth. It is not competitive in Nebraska where coal would have to be hauled to the generation plant, not even competitive when moved by barge on the Missouri River. To bring industry to Nebraska, we must have ample power competitively priced. This can best be done by large nuclear energy plants such as the Cooper Nuclear Station at Brownville, Nebraska; and it has the advantages of ample water without ecological disadvantage and location in an area of low population.

I have one specific criticism of the accuracy of this article, and that is the map on page 8 "Nuclear Plant Locations," which lists the two plants in Nebraska: the northern plant, the Fort Calhoun Plant, being built by Omaha Public Power District; and the southern plant, the Cooper Nuclear Station,

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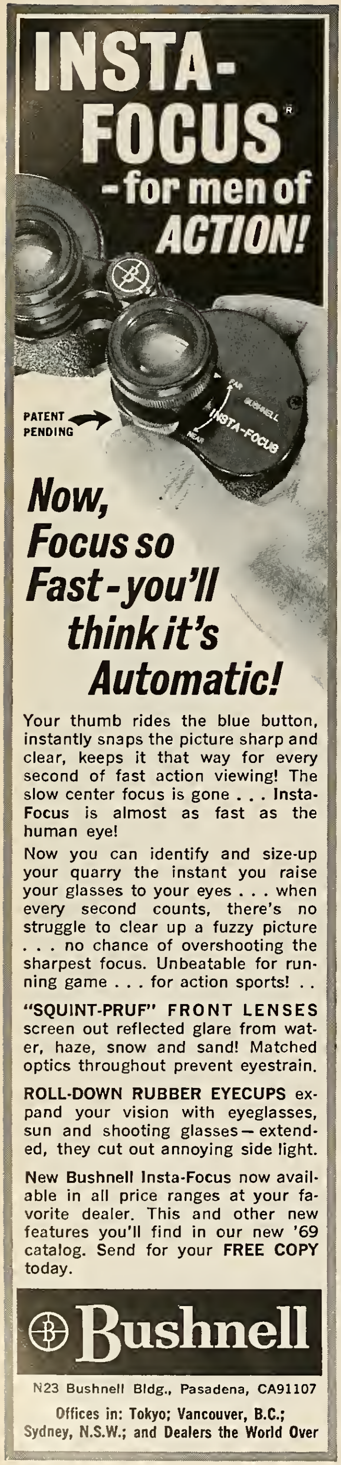

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being built by Consumers Public Power District, as being "Planned." I have in front of me Cooper Nuclear Station and 345 KV Transmission Program Progress Report, January, 1969, and while it is not a public report, it does say "The overall project is an estimated 10.8 percent complete; and within budget." So 10 percent completion of a $225,000,000 nuclear facility is certainly beyond the planning stage.

In conclusion, I would comment that the points brought out by the article are real and important. The unfairness comes in, in not covering how these important problems have been judiciously and scrupulously handled. As for instance, the Cooper Nuclear Station was excavated to within nine feet of bedrock, and the fill was then remade with properly sized material and properly compacted as it was refilled. There has been scrupulosity at each stage of our building and planning of the Cooper Nuclear Station, and I am confident that under the careful eye of the Atomic Energy Commission, and good intentions of all concerned, that the same would apply to other developments, always building on the expanding technology and experience that has been developed.

Of greatest concern to me is that the waste products of any plant, whether from products of combustion, chemicals, garbage, or thermal perturbations are provincial in nature and must be evaluated on the same basis. For example, a ten degree rise in water temperature may be damaging in one area while a twenty-five degree temperature rise may be beneficial in another area. Generalizations simply cannot be valid.

Guy L. Cooper
Humboldt, Nebraska

The authors, Richard Curtis and Elizabeth Hogan, have skillfully put on the blinders in order to portray and distort one side of a story. Indeed their biased account can fill the average person with sickening apprehension. Their reasoning reminds us of the old couple down south who refused to permit their children to be given the blessings of electricity. The couple had read that electricity could kill you, and they would have no part of it.

Now I wish to emphasize that I am much concerned about the increasing amount of contamination (pollution) that is being released into the environment. I refer to the pollution from automobiles, industrial plants, and chemicals used to control insects and other pests. I am not, however, so opposed to pollution at the present levels that I am willing to give up my automobile or the sweet corn I obtain fr my garden.

Although the article is directed wards the potential hazards from actors, I wish to call your attent to a few of the benefits that acc from its products. The power prop ties of these reactors are wid known, so I will confine my speci remarks to radioisotopes and their r in our society.

The authors state that radiation h been positively linked to cancer, le kemia, etc. However, they make mention of the millions of potent cancer victims who are alive and apparently good health today becau of the blessings of the peaceful ato Did they know that radioisotopes a used to diagnose and treat betwe three to four million patients a yea and that some 250 of the nation largest corporations now use radiois topes in their manufacturing proces es. Radioisotopes are used to impro the quality of steel products, autom bile tires, and petroleum product which in turn help to provide a hig margin of safety both on the highwa and in the air. They are also used assure that you get a full measure canned products, such as apple sauc peaches, and even beer.

Today there are over ten thousan institutions licensed to use radiois topes. Yet, authorities tell us that the are unable to document a single cas where a person has been injured whe isotopes are used under responsibl supervision. The U. S. Atomic Energ Commission conducts a diligent pr gram to assure that only responsibl handling of these materials is pe mitted.

If the authors wish to put the ha ards of the atom in perspective, the should compare it to a few other every day hazards. The odds of getting seri ously hurt or killed in an automobil accident are very unnerving. There i enough gas in the mains under th streets to asphyxiate everyone in major U. S. city. The odds that you home furnace may malfunction an burn both you and the house are cer tainly worthy of consideration and o much concern. Shall we declare moratorium on technical progress move back into caves, and blissfull live out the remainder of our days?

The authors failed to provide the other side of the story. Their article can only cause unwarranted fea among its readers. Sure, we must al recognize that there are risks in each thing we do. We must, therefore, learn to weigh the risks against the benefits. Only then can we make logical decisions.

James W. Hitch
Damascus, Maryland

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Under the Spell of the Zodiac

An ancient, emotion-laden science, astrology still gratifies man's appetite for worship of celestial bodies

by Mark Graubard

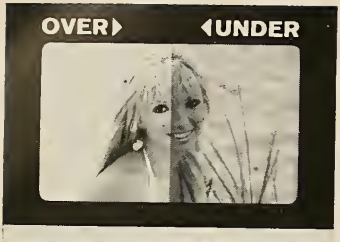
The upper strata of the earth's rocks are full of diverse traces of plant and animal forms whose existence was terminated by the turbulent crosscurrents of evolution. Similarly, the history of man's efforts at objective, verifiable, and communicable knowledge of the workings of the world about him is replete with dead theories, and even dead goals and values. And just as the botanist, zoologist, and geologist honor the dead and study their fossil remnants to gain broader and deeper knowledge, so must the student of science honor the past to better understand the scientific thought processes and their operator, man. The history of science being young, many of its laborers are not fully aware of the vast possibilities that an objective study of the past can offer toward the understanding of man and his frequently wayward conduct in the pursuit of scientific knowledge.

Ancient man lived literally in the womb of nature, tied to its tissues and bloodstream not only with bonds of respiration and nutrition but also with chains of deep emotions: fear, hope, pleasure, and horror. Foremost in his natural environment were the heavens, particularly the moon with her cyclical changes from invisibility to fullness, from a crescent with tusks pointing west to the reverse position, from a path high in the sky to one above the horizon. Then there was the sun, shifting almost daily its points of rising and setting and its elevation at noon. Next there were the stars that remained fixed among themselves, clearly distinguished from the five wanderers—the planets seen with the naked eye—that roamed up and down the zodiac belt even more strangely than the sun and moon. In addition, there were occasional shooting stars, comets, and eclipses. One had to be exceptionally witless not to feel the awesomeness of those events and a desire to learn their meaning.

Man is primarily a feeling, responsive animal. His deep emotional reactions to celestial phenomena have traditionally manifested themselves in the form of religion—man's rationalized conceptions of his relation to nature, to the purpose of life, to death and disease, to sin and virtue, to other men and women, and even to proper food and conduct. The celestial bodies came to be regarded as symbols of powers and were honored everywhere because their strangeness or divinity, and their impact on man, were universally recognized. However, in ancient Babylon, during its varied growth from Sumer through Akkad to Chaldea, the feeling toward the heavens became inflated and evolved into the very hub of its religion, hence, the entire nation's life and outlook.

There is much in the records of ancient Babylon to tell us how star worship evolved. Already in the *Epic of Creation* of Sumer-Akkad, or Early Babyon (*ca.* 2200-1900 B.C.), we read:

> The Star-Jupiter who brings
>   prophecies to all
> Is my Lord. My Lord be at
>   peace.



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The sophisticated myth of Tammuz, the sun, describes his capture by winter and his release in the spring, thus generating the recurrence of the seasons, the cycle of growth, death, and resurrection. Venus, or Ishtar, was portrayed as the self-sacrificing mother, a virgin queen, a goddess of the harvests, and in other roles.

The Babylonian priests were men of thought and wisdom, the leaders in worship: they lived and worked in temple-towers erected to the gods who represented the planets and ruled the earth. Some priests excelled in poetry and spun beautiful tales of the planets as gods symbolizing significant forces and events. Animals were also honored, and each planet was linked with a favored animal, which in turn gave rise to a rich crop of joined symbolic lore. Other priests were more concerned with the technical aspects of planetary positions and recorded as accurately as possible their devious movements, thus laying the foundations of the science of astronomy. Still others were socially conscious, and these gave rise to astrology. All three branches apparently evolved side by side as befits the multifaceted nature of man and the process of cultural enrichment. Since a field once opened up can grow and grow, astrological speculations and interpretations expanded and deepened. Each planet, or god, came to have a specific meaning in its every position, and so did each celestial event.

There was much travel in ancient times, especially among scholars. Consequently, astrological lore soon reached Greece where astronomy had prospered greatly due to progress in geometry, Euclid's collection appearing around 300 B.C. Astrological theories were welcomed there, and as a result, the omens and prognostications that the experts read from the sky became more systematized. The basic beliefs were hardly questioned by the enthusiastic astronomers who were stimulated by the romance and scope astrology added to their geometric labors. Horoscopes, or readings of the sky's layout at births, won wide popularity, and because Greece was a democracy, they came to be applied to individuals, not only to kin as in autocratic Babylon.

By the second century A.D. astro ogy had become so rich and stan ardized that the great Claudi Ptolemy issued his *Tetrabiblo* which remains astrology's bible t this day. Ptolemy had previousl written the *Almagest,* an ingenio mathematical elaboration that unite all known astronomical data int a most coherent and logical theor with the earth as an observatio platform and the celestial events a seen from it—a reality that could nc be denied at the time. Ptolemy live and taught at Alexandria, Egyp which remained for about eight cer turies the center for the world's pu suit of scientific studies.

The backdrop of astrology wa the effect of celestial events upon lif on earth. There are such effects. Th sun's action is known to all, and th moon's effect on tides, as well as o the habits and breeding patterns o many marine animals, has bee known since earliest antiquity. Jus as an inspired lover of nature ca be swayed to dream and act by it enchanting and enslaving power ove him, so a lover of stars could b moved to visualize and submit to th dictates of his idol, the celestia powers. To him, glaring Venus bright-beamed Jupiter, morose an distant Saturn were as real as th class struggle is to a Marxist, racia equality to an egalitarian, behaviorism to a Pavlovian, or psychoanalysis to a Freudian. The action of th sky was real, but limited, but its devotees would not recognize an limits. They extrapolated, as most believers do: what was true for a segment was true for all.

At the center of astrology lay the horoscope. The year was one revolution of the sun, shifting eastward from a given position against the stars, all the way back again to the very same spot. Today, we say it is one revolution of the earth around the sun. The horoscope is based on an interpretation of the northern half of earth's enveloping sphere of sky, cut along the celestial equator, and divided vertically into twelve equal segments. The base of each segment is an arc of 30 degrees along the equator; upon each arc rests a triangular sky segment with its apex at the North Star. Laid out flat, these segments of the sky-dome are called

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Lester Davis is a friendly, dark- little boy whose smile can light n entire room. But for most of ix years, he hasn't had much to e about.

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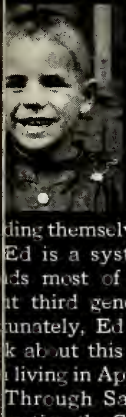
Lester's father, Ray, used to work he coal mines, but since the es "played out" he's been unem- ed. As Tressie admits, "It's aw- ard going. We never could get good start before." They still ln't have a "start" if it weren't he Cossum family.

Ed and Martha Cossum live in burban community of contem- ry homes. Looking out back you see one of those large, above-ground plastic swimming pools. And you can see the beginnings of a redwood deck around the pool, which Ed and his two children, Bill and Carol, are ding themselves.



Ed is a systems analyst. He ds most of his day thinking t third generation computers. unately, Ed and Martha also k about this generation of children living in Appalachia.

Through Save The Children ration, the Cossums are helping er and his family. They contrib- $15 a month. Though it's not a f money, the Cossums could ably have done a lot of other gs with it.

The Cossums' contribution will nade available to the Davises s a gift, or charity, but as a loan. nterest-free loan which Lester's er can borrow to begin a self- project.

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houses. In addition, there are the twelve constellations of the zodiacal belt, the circle of sky against which the sun is viewed. The houses merely serve to form a grid of the sky for each horizon, while the signs of the zodiac designate the stars, which shift to make a full circuit in the course of the year against the fixed grid of houses. The same house at any given horizon will have different signs of the zodiac at different times, and on occasion two signs in one house. Thus, by taking into account the place of birth, hence the sky at that horizon, plus the signs in that sky and the positions of the planets in the signs, quite a diversity of combinations can be obtained.

Assign meanings or powers to these variables. Then if you find the region of House One to contain Jupiter at 10°20′ in the constellation Sagittarius, as well as Uranus at 6°15′ in the same sign, Saturn in another house in the same or a different zodiacal sign, the moon at 12°6′ in Taurus in House Five, etc., you can obviously have a complex story unfolding as a result. It can be an exciting game, far more so than other games of chance and design, because it has a façade of seemingly scientific determinants, plus a strong involvement of the ego and its emotional tensions. Moreover, details can be spelled out in ways that make verification difficult. In fact, all prediction in human affairs can be made so as not to permit it to be decisively adjudged right or wrong.

How the various astrological elements were assigned their specific meanings remains a mystery. It seems that in antiquity everybody took it for granted that the Chaldean (Babylonian) experts had accumulated data for thousands of years, and that they therefore based all qualities and powers on a strong, empirical foundation. There is, however, no evidence whatever for this, any more than for the belief that medicinal powers attributed in ancient and medieval times to various herbs were derived from agelong observation. It is far more reasonable to assert that all powers assigned to houses, signs, and planets were products of the imagination, as were the amazing medicinal properties ascribed to the mandrake, garlic, cabbage, or cinnamon. Occasionally an actual power of a plant crept in s a true cause, but that happened in nly a small number of cases.

And so it transpired that House ne, for example, was believed to ule personal appearance, especially he head and face of the client, who vas called the "native." House Two overned wealth, personal liberty, ars, neck, and throat. House Three overed relatives, journeys, education, arms, shoulders, and lungs; and o on. Among the signs, Aries controlled life, energy, vigor, and leadrship. Taurus involved conservaion of energy, secretiveness, and reed. Planets had their home houses n which their special powers were trongest; when in other houses heir powers varied, and were more ubject to the astrologer's whim in nterpretation. Also positions, or spects, in relation to other planets vere significant. Clearly, the thorugh reading and interpreting of a oroscope was no mean task and was ubject to the performer's personal udgment.

Just as the Chaldean astrologers ound their ideas avidly received in reece, with the rise of Roman domnation, Rome too took to astrology vith fervor. The Stoic philosophy, vhich honored the laws of nature nd believed in man's inevitable ubmission to them, found in astrolgy their most ideal expression. o amount of zeal and propaganda an, as a rule, achieve what can be ccomplished by a fortuitous combination of the current fashion and he right set of man's internal needs. Rome's loose religious outlook, which tolerated all faiths and incorporated many foreign gods into its wn divine tribe, quite naturally weakened faith in general and prepared the stage for astrology's strong footing. The astrological belief web was not a religion but a way of life—the very acceptance of Mother Nature, the rule of science, the workings of natural law. So strong was its appeal that its spread was not at all hampered by the several legislative acts introduced against it in an effort to subdue plotters and lawbreakers who consulted astrologers to help them in their antisocial acts.

In spite of its rapid spread, the astrological belief pattern met with tough though isolated opposition in Greece and Rome from the very beginning. The criticism stemmed

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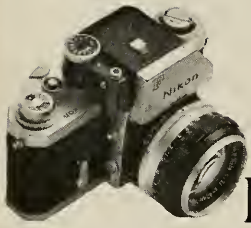

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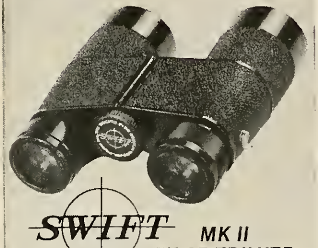

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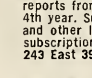

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from logical, moral, social, and r ligious grounds. Those who advanced it believed, nevertheless, i some aspects of the star lore. Greec had produced a firm skeptic in Ca neades, the founder of the Ne Academy, a man whom Cicer (106-43 B.C.), the greatest skepti among the Romans, greatly admire and often cited. Carneades' origina works are lost. Fortunately, Cicero' book *On Divination* forms an excellent summary of all previous criticism mustered against astrology an is, besides, much fortified by hi own critical mind and vast erudition. Ptolemy himself duly listed an weighed all the weaknesses of astrology and answered them pleadingly apologetically, and quite fairly. Th two most popular writers on science Pliny the Elder (A.D. 23-79) an Seneca (*ca.* A.D. 1-65) also criticized astrology and yet they retaine their general beliefs in stellar powers. And in Christian Rome, St Augustine (A.D. 354-430) adde many strong religious objections.

Yet astrology survived them al and parried all attacks with wondrous skill. It retained both its glamour and status from the days o academic-minded Athens, erudit Alexandria, and imperial Rome, t salvation-oriented Christendom, until around the middle of the eighteenth century. Only after the new astronomy—founded by Copernicus Kepler, and Newton, and equipped by Galileo with the power of the telescope—spread into public awareness did the fantastic vistas of a new era brush astrology aside. The eyes o the moderns were fixed on more exciting, more fashionable horizons which revealed new thrills by the day. Astrology was left friendless as the new generation of astronomers mocked and derided her and wondered how she could ever have attracted men of scientific genius.

The arguments against astrology read like this: How come that at exactly the same location and moment with the same signs in the same houses, and with planets in the same aspects, three boys are born and destiny renders one a poet, one a prince and one a pauper? A foolish question, replied the astrologer. Stars d not act by magic, any more than fire an arrow, or a flood. These infant came from different drops and grew in different wombs. Their seeds (o enes) were different. So was their nvironment—social, climatic, and ultural. Hence their ideas, energies, mbitions, and powers evolved differently. How about twins, born hree hours apart and yet identical? Clearly, came the riposte, this indicates that the infants were conceived t different times. Laughable logic? Not really. Surely, today we think nd reason along similar lines. In order to save a theory, every believer justifies any situation that may seem ontradictory by suggesting all kinds of reasons for deviations from the rule, and at times this procedure is fully justified. Next, what about twins born half an hour apart and nonetheless different in sex and fate? Answer: Half an hour means 7½ degrees motion of the sky, which can make a big difference.

"Persons born with certain congenital defects have been restored . . . by nature herself," says Cicero, and "men who were so tongue-tied that they could hardly utter a word have been liberated by the surgeon's lancet." This same argument was advanced in many forms. Its intent was to say that astrology preached a fatalism that was a danger to the individual and to society. Men will not endeavor to improve or fight adversity if they believe that their fate is set and sealed, it was claimed. Moreover, a man can argue in court: "Your honor, how can I be punished for having killed my mother-in-law when I was born under Gemini with Jupiter in Taurus. . . . My fate dictated my deed." St. Augustine added to the case against astrology: "Has God created the planets and placed them in their orbits so that they should run the world while He in His wisdom is retired forever, dormant and useless? What then is the use of prayer and sacrifice?"

But the astrologers answered these arguments. The wise man rules the stars, was their slogan. Knowledge of what the stars presage is valuable precisely because man can then know how to modify their predicted course and be truly master of his fate. The principle of free will, upon which the Christian faith rested, was thus spared, and the stars were declared to act in harmony with God's will, never against it.

With the collapse of the Roman Empire, schools and commerce ceased, while Christianity remained

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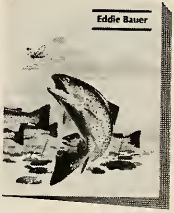

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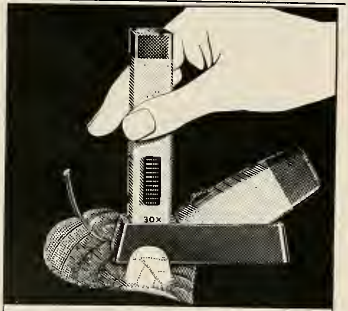

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the common bond of the West. Men who desired learning and wisdom entered the Church and studied the Bible and the saints, rather than ancient science, because the new ideas of faith and salvation were more attractive and fashionable. In the meantime, however, science began to prosper in areas under Moslem rule, and by the eighth and ninth centuries A.D., ancient scientific works, translated into Arabic, had found their way into the great Moslem houses of learning from Cairo to Cordova. Later, once the Christian West became stabilized, its scholars learned Arabic and revived the neglected ancient science.

Astrology thus came back to the West. And in the thirteenth century Roger Bacon in his encyclopedic *Opus majus* indicated, amidst much criticism of astrology, how coexistence between Church dogma and astrology had been attained. The formula was simple enough. True astrologers "know that the divine rule can change all things according to its will." But astrology must not be condemned outright, because "the forces of the heavenly bodies and the strong species [action, power] of the stars [are] able to affect the body and its organs. . . . The skillful astronomer is able not only in the things of nature, but also in human affairs to consider many things regarding the present and the future and the past. . . ." And all through the Middle Ages this working compromise persisted. The love of science of the skies and the love of God and Christ got along famously together. Every now and then a skeptic issued forth his critical call, but it never amounted to much because the basic notion that celestial bodies influence events on earth persevered through thick and thin.

Astrology was never defeated; it declined from desuetude, hence fatal neglect. The new was too dazzling, too absorbing, and too productive for the true lovers of the skies. Strangely enough, the very men who laid the foundations for the new science that spelled astrology's doom were believers in astrology and even practitioners to various degrees.

Ancient astrology is derided to this day by all scientists. Yet history has hidden vengeances in store, at times. Medieval alchemists were viewed as charlatans, defying and denying the concept of an unchangeable element, until 1918, the year Rutherfo proved the reality of transmutati by obtaining oxygen from nitrog bombarded by helium. After that c covery man, looking back at the m dieval alchemists, viewed them visionaries.

Will astrologers, too, like the chemists, someday be given the ti of visionaries? Astrology possess all the qualities of a young, naï emotion-laden science and cater in the past to man's sense of awe, his sense of insecurity and wishf ness before the forces of nature, his love of lore and poetry about n ture, and to his desire to be speci with a bewildering multitude of u knowns. Today its services are li ited. However, those who are in ear est about the study of man and t nature of science must peer deep into the astrological era—its rise, i struggles, its decline—and into t resurgence of interest that is occu ring today.

Why is astrology currently stagin a remarkable comeback among t general public? My answer is spec lative, but I believe, tenable. Ours an age in which romance, sentimen patriotism, religion, and moral va ues have either been banished or a derided. To some, life seems to be a oppressive vacuum, frustrating an tormenting man's spiritual needs This has apparently resulted in need for faith and a desire to specu late about life's purpose and man' fate, as in affluent, decaying Rome. I we look at science as the interactio of man's mind with the forces of na ture, we find that at one end o the process is the height of scienc reached through objectivity and th formulation of concepts, while at th other, emotionalism often wins th upper hand and comes to dominat one scientific horizon or another. Astrology, then, seems to satisfy the de sire for science as well as the need fo faith, for belief in powers that rul and manipulate. Moreover, the tri umphs in the exploration of spac and the new discoveries of astronomy increase man's appetite for renewe worship of unknown powers.

Astrology will stay on and probably prosper. The times and the vast advances in space and stellar realms favor it. But its reign will be outside the observatory, outside the society of astronomers. Its revival is a social not a scientific, phenomenon.

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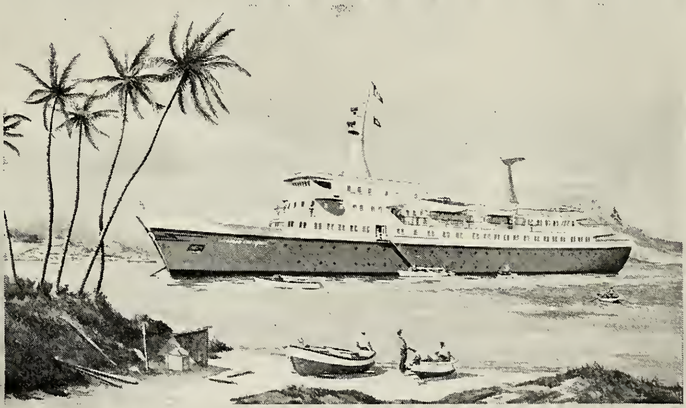

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Pop Goes the Weasel, Pffff Goes the Whale

by William A. Watkins

It was the first time I had really listened to the blows of a whale. I had seen whales many times before but always from noisy ships. Since the blows are often all that may be seen of a whale at sea, I knew that whales "blew." I knew that they were air-breathing mammals, and I knew that their blows were audible. In fact, I had read in whale stories of "loud and horrible noises" that accompany whale blows. But this was my first opportunity to actually listen to a whale blow. We were in a small boat drifting in Cape Cod Bay. It was flat calm.

Pffff! The sound startled the sea. It had an explosive quality that brought all senses acutely awake. Suddenly, I was noticing everything. We had been still on the water fo some time when the blow slashe through the quiet. In the trough o the small waves a dark form showe momentarily, and a low cloud o vapor rapidly disintegrated abou five boat lengths away. Anothe blow! It came with a suddenness tha lifted nerves on edge. It was close this time and seemed very loud. Bu

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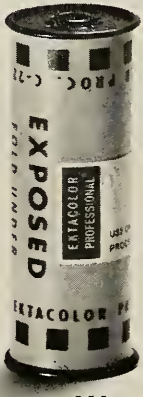

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I reflected that this loudness was really in contrast to the silence of the swells. Yet it did stand out sharply. And it was such an abrupt sound. Another blow! Just about abeam of us now, and this time it was not unexpected at all. I noticed that I'd been waiting for it—tense. Consciously, I relaxed and commented in a whisper that somehow this blow was different. It didn't appear to be as sharp or as sudden. Was this just because it was expected? My whisper seemed loud too. Another blow! Definitely, there was a difference in quality. This blow was quieter or lower in frequency or slower. Was each succeeding blow more subdued? My whisper had returned all sounds to their normal relationship, and while this blow wasn't especially loud, still it was sudden. Perhaps the abruptness of the blow had made it seem so much louder.

The whale literature is vast and covers the entire spectrum of sea stories, from careful descriptions of whaling in sailing vessels to entirely frivolous tales of high adventure on the ocean. Very little of this is objectively written. Instead, most encounters with whales are embellished with exaggeration. The carefully written accounts of whaling turn out to be entirely about the men and include nearly nothing about the whales.

Most descriptions of whales and their habits are based on short exposures to these animals and simply illustrate that we know little about them. The exaggerations in the literature seem to result from (1) the feeling that nobody else knows any better, (2) the large size of whales, which inspires tall tales, and (3) the fascination of their air-breathing but aquatic life, which appears to stimulate the imagination. Nobody ever watches a whale for extended periods in the same way that we learn about terrestrial animals. We can't. A whale is only visible when it comes up to breathe, and not always then. Whales sometimes exhale underwater, and then inhale quickly with nothing but the blowhole above water. Even the water in which they live often has limited transparency, sometimes no more than fifteen to twenty feet, not enough even to see the whole animal at one time underwater. This makes it rather difficult to learn much about their lives. How they feed or raise young or navigate—all of these are still mysteries. We don't really know, so we guess.

The only part of their existence that is accomplished in plain view is their breathing, but even here uncertainties abound. What kind of whale did we see? It takes a lot of practice to tell one whale from another. Was there only one animal or were there two or three emerging to breathe? How deep had they been and how active were they before they came up to blow? All these questions are important for a real understanding of the one whale action we can most easily observe, a blow.

The "blow" is the whale's breathing. A whale comes to the surface, raises the blowhole (which is one nostril or a pair of them, depending on the kind of whale) out of the water, exhales, and then inhales. Breathing is apparently a voluntary process for the whale. The exhalation is abrupt; the blowhole opens and (even as it is opening) air is rapidly forced out. In less than a second about a cubic meter or more of air is expelled through the blowhole, which in its greatest dimension measures only about one by five inches. The air that has been under pressure and warmed and moistened is suddenly forced out. It expands rapidly and the water vapor condenses. This is the plume of white that visually marks a whale's blow. Sounds of air turbulence also may be heard as the stream of air is forced through the relatively narrow opening; this is the sound that accompanies normal whale blows.

The last part of the whale's breathing cycle is intake. Inspiration is short, less than a second, usually shorter than expiration. During inhalation the blowhole is opened a bit wider than during exhalation and air is sucked in rapidly. Very little sound accompanies inspiration because air is going into a slightly enlarged blowhole at less pressure, and any sounds of turbulence are confined mostly inside the submerged animal.

Descriptions in the literature of sounds of blows from apparently healthy animals are interestingly varied and perhaps reflect the variety of backgrounds and experiences of the authors. Most of the early accounts by whaling experts simply emphasized the apparent loudness of the blow, and then more picturesque qualities were sometimes added: "A sort of deep bass snort, extremely loud and somewhat prolonged" as "the rushing of steam at high pressure from a large pipe" (Moseley, 1879), "a kind of bellowing" (Du Tertre, 1667), "a loud metallic sound, very closely resembling the puffing of a Mississippi steamboat" and "a hoarse bellow" (Nordhoff, 1940), "a puff of steam" (Scoresby, 1823), "belching forth its quick ringing spout," "its hollow-sounding respiration can be heard a long distance" (Scammon, 1869). The most spectacular description comes from the pen of Davis (1874) and has been repeated by many authors since. He tells of a blow "as noisy as the exhaust pipe of a thousand horse-power steam-engine." When heard in an environment before the era of vibrating, noisy ships, these blow sounds would appear to be much louder than they really were.

Subtle variations and differences in the sounds of successive blows do exist even from the same whale: perhaps it is this variableness that has given rise to some of the variety of opinion noted above. In a normal series of breaths after a short dive these variations are slight, but after a prolonged dive successive blows are noticeably different. The first blow is likely to be abrupt, starting with an explosive rush of air; later blows become more leisurely and less loud. The last breaths of a series may be little more than puffs of air.

The variation in whale blows perhaps is emphasized by individual differences and by varying lengths of submergence that, as Andrews (1909) observed, presumably affect "the force with which the breath is expelled." It is possible that depth and the amount of activity while submerged also affect a whale's breathing, just as exercise and stress affect ours. With the apparent decrease in the force of breathing, successive blows of a leisurely whale have less and less high-frequency noise and are less loud.

In contrast, a whale that is apparently under stress almost pants, breathing heavily and more often. A whale in a dead run before a vessel does this. It swims hard just below the surface; it arches high out of the water, blowing quickly and more and more often. This is taken advantage of by the modern,

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fast whale catcher; the whale is scared into running before the ship, thus providing an increasingly easier mark for the harpoon gunner. Inadvertently, during research, as we have tried to get close and positively identify a particular whale, we have startled whales, finbacks especially, into running before the ship. All the blows of any frightened whale can be described as "explosive."

A whale blow is an uncommon experience for most people; consequently, it often is difficult to equate their descriptions of these sounds. Shared experiences of an ordinary kind allow us to compare the sounds we hear, but generally, we do not notice that each of us hears the same sound a bit differently. It is not until we try to describe an unfamiliar sound that we realize the diversity of opinion. The descriptions in the literature doubtless are affected to some degree by this. To keep away from such confusion, scientific descriptions of new sounds avoid subjective impressions, and instead are in terms of the physical parameters (frequency and amplitude composition relative to time). Sound spectrographs provide a means of writing sounds to indicate these qualities. In spectrograms, which exemplify normal blows, frequency and time are plotted on the scales, the intensity differences show as relative darkness of the trace. The usual sound of a whale blow is that of a puff of air; in spectrographic terms it covers a broad band of frequencies with not much energy at any particular portion of the spectrum.

Even considering all the diversity of opinion to choose from, as well as the observed variation in whale blows, the descriptions in the literature of unusual sounds associated with blows are still puzzling. Some of the accounts were graphic and detailed and were written by careful men. Could it be that sometimes whale blows actually did contain fairly loud, peculiar sounds? Matthews (1938) describes a right whale off New Zealand that sometimes blew differently from the other whales he saw. It "kept blowing with a very loud tinny noise, sounding as though it was blowing at the end of a very long drainpipe." Rawitz (1900) noted an unusual series of blows by several pairs of humpback whales. These he characterized as loud, howling sounds that progressed upward through several frequencies, lowering at the end. When the whales were approached they no longer produced this sound but returned to their normal blowing. Were their "howling" sounds made on purpose?

Sounds that are made in air are not normally audible underwater; the interface between air and water does not readily transfer sound. Why then would a whale be making sounds in air if it cannot hear them underwater? Whales and porpoises do make a variety of sounds underwater, which of course they can hear, and at least some porpoises use sound in echolocation and orientation. These sounds are produced entirely underwater and except for the very loudest ones are not audible in air. The in-air sounds that are heard from performing porpoises (such as television's Flipper) are taught to them by their trainers. These sounds are not associated with their breathing even though they do emanate from the open blowhole. The animals are also trained to open their mouths to make it seem that they are talking, but the sounds do not come from their mouths. The usual underwater sounds of whales are not made with their mouths or their blowholes—these sounds may be quite loud, although generally no air escapes during underwater sound production.

It was several years before I got any more answers to my questions about whale-blow sounds. Then one fall day, three fifty-foot humpback whales passed slowly by, blowing loudly with peculiar, long-drawn-out wheezing blows. We were a few miles northeast of the tip of Cape Cod, listening underwater for whale sounds, when the three came by. Normal blows were mixed in with the wheezing blows. These wheezing sounds apparently were repeatedly produced at the blow-hole by all three animals and seemed to be made in response to each other. The wheezing sounds were much louder than the sound from their normal blows in air; and underwater they were as loud as the whale sounds usually made underwater. In contrast, the normal blows they made were nearly inaudible under water.

The wheezing blows appeared to

be produced at will. The sounds from nearly thirty of them were recorded from the three animals in air and underwater during one fifteen-minute period. A whale would raise its blowhole well out of water and blow slowly, apparently constricting the open blowhole until a wheezing sound resulted. The wheezing blow lasted one and a half to two seconds and was quite variable from blow to blow. Since the sound was heard well underwater, it is probable that air inside the whale, as well as the outside air, was set to vibrating by the constricted blowhole. Two spectrograms that were taken of the same wheezing blow show that the sound has the same general characteristics in air and underwater. In contrast to normal blows, the wheezing blow emphasized specific frequencies, which varied with the apparent degree of constriction of the blowhole.

The whales were not making these noises for our benefit, but for theirs. The in-air portion of the blow sound was undoubtedly incidental. They were listening to the underwater component and probably did not know or care that "horrible noises" were produced in air. Many of the descriptions in the literature of noisy blows from whales may have had their foundation in something like these loud wheezing blows.

The old whalers were said to be able to tell a lot about a whale by just being nearby to listen for a few blows. Indeed, the experience these men undoubtedly amassed may have enabled them to give at least gross estimates of size and kind of whale, also perhaps fairly good guesses as to age or sex, duration or depth of dive, contentment or fear or rage. All of this and perhaps much more they would have considered to be indicated by the sound of a whale blow. Unfortunately this kind of intimate knowledge, developed during the days of quiet ships and many whales, may be unobtainable now. The populations of all the large whales are drastically reduced because of overhunting, and our ships are noisy, machine-driven vessels. Many, perhaps all, self-respecting whales object to coming close to such ships. And even if they did approach, who on board would find it easy to hear the sound of a blow from even a Moby Dick?

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The Shreds of Ancient Persia

A cache of gold uncovered in modern Iran illuminates the dim artistic source of the ruins of Persepolis

by Bernard Goldman

In 1947 two shepherd boys stumbled across a cache of ancient gold near their remote hamlet of Ziwiyeh in Kurdistan, in the northwest corner of Iran. When the villagers heard of the marvelous discovery, they collected what the boys had found, scoured the hillside for more such valuables, and finally amassed a hoard of gold and silver along with pieces of the bronze tub that held the treasure. At first they threw away many "stone" slivers found with the gold, but later a careful reexamination showed them to be fragments of delicately carved ivory. The villagers divided the spoils, tearing up many of the gold ornaments to insure that every man received his fair share. Before long the mutilated treasure was in the hands of dealers and on the commercial market. A whirlwind of buying scattered the hundreds of valuable pieces into public and private collections in the Near East, Europe, and America. While we cannot be sure that this story of the discovery is entirely accurate, it has the ring of truth; of the mutilation and subsequent scattering there is, unfortunately, no doubt.

Students of Iranian art and culture have kept a careful vigil over the whereabouts of the lost fragments as they "surface" around the world. For the past twenty years we have traced bits and pieces, trying to put the treasure back together. Its reconstruction has assumed the proportions of an international jigsaw puzzle. By matching and comparing photographs of gold and ivory slivers scattered here and there, we have gained a partial picture of the "Treasure of Ziwiyeh" when it was first uncovered.

But a complete catalog and photographic record of all known pieces were needed. For this purpose I had been gathering material, documenting the several collections. Only that in the Archaeological Museum in Tehran had not been recorded or fully photographed. Last year the museum authorities in Iran granted me permission to examine the Tehran holdings. Accompanied by George Booth, my university's chief of still photography, and my wife and son—who acted as registrars for the growing catalog—the several hundred Ziwiyeh fragments in the Archaeological Museum were documented.

In the south of Iran, at Persepolis, we spent time measuring the style of Ziwiyeh art against that of the Persian Empire. For therein lies the importance of the treasure, the reason why it has commanded scholarly attention since its discovery.

The treasure of Ziwiyeh is the only collection known of artifacts from a region and culture that were to become an integral part of the greatest empire the ancient world produced, that of the Persians and the Medes. This dominating force, the Persian, or more properly Achaemenian, Empire, is popularly remembered as the villain of ancient times, when European civilization was in its infancy. We immediately take the side of the outnumbered, outgunned, underdog Greeks who held their ground at Marathon, Thermopylae, and Salamis against the Persian invaders. The troops of King Darius and of his successor, Xerxes, were defeated by the valiant Greeks, but the Persians still held an empire that covered all of western Asia and northeastern Africa.

Almost one hundred and fifty years later, in the latter part of the fourth century B.C., the Greeks had their final revenge, marching into Persia under the youthful Alexander of Macedonia. With the recklessness born of genius, he swept over western Asia, crushed the Persian armies sent against him, viewed the body of the murdered Darius III, last of the Persian kings, and finally stood in triumph before the great, gleaming holy "city" of Persepolis. Here the Persian monarchs had built their palaces, kept the royal treasury, and received the oaths of submission and the gifts of the tribute nations. Alexander's troops stripped the buildings of treasures that later Greek writers were to describe with awe. What happened next is a matter of gossip. Some ancient authors claim that Alexander sought revenge for the Persian sack of Athens, some say that in a fit of drunken exultation he ran with flaming torch to the palaces, and some maintain that he was innocent of any malice. But whatever the motive, Persepolis was set ablaze, a symbolic funeral pyre of a great nation overthrown. This destruction, tragic as it was, also preserved the sculptural and architectural grandeur of the Persians and the Medes, for it safely buried, beyond further harm under masses of burned timbers and collapsed mudbrick walls, a wealth of carved stonework.

While Parsa is probably the name by which the Persians referred to the palace area, the Greeks called the site the "City of the Persians"—Persepolis. Its modern name is Takht-e-Jamshid (Throne of Jamshid). Today, an hour's drive east from Shiraz brings the traveler to Persepolis at the foot of the Mountain of Mercy (*Kuh-i-Rahmat*). Darius, late in the sixth century B.C., leveled a broad spur of the mountain that reached out into the plain, and faced it with a stone revetment to provide a high terrace upon which his architects could erect the

Eagle-griffins, common beasts in Persian art, decorate stone capital at Persepolis, left. Carved in relief, below, Median lords carry lotus flowers on ascent to royal ceremonies.

The lion preys on the bull on a staircase leading to richly decorated terrace.

portraits of the kings and their retinues on the door jambs of the palaces raise the vision of a cultured, highly sophisticated people with a long tradition of first-rate craftsmanship and superb artistry. It is at this point that the Treasure of Ziwiyeh is of critical importance for it links Persepolis to the artistic past of ancient Iran, and helps to answer the question: What are the sources of Persian culture?

On the walls at Persepolis are carved portraits of Medes and Persians, the two related peoples whose consolidation formed the Persian Empire. The Medes wear knee-length tunics over high boot-pants, brimless "bowler" hats with tassel, and carry a dagger slung from the waist in an ornamental scabbard. The Persians affect ankle-length, draped robes, gathered at the waist by a band through which a dagger is thrust. A fluted hat crowns the head with its oiled and perfumed snail curls. The ancestry of these court dandies is subject to question. Written records, place names, and other circumstantial evidence suggest that the early clans of Medes and Persians migrated down from the north, from the Caucasus.

The annals of the Assyrian kings, those long, self-congratulatory histories carved on the walls of palaces, are one of the most extensive sources for the reconstruction of these early days. In the recounting of their military victories, the Assyrians speak of the land of the Madai in northwest Iran, which must be a reference to the early kingdom of the Medes. The annals also mention the land of the Manneans to the north and west of the Madai. Until fairly recent times both these people, Madai and Mannai, existed only on paper. Modern excavators are working on the problem of finding and identifying the physical remains of the cultures of these precursors of the great empire. Unfortunately, the Treasure of Ziwiyeh, found in the land of the Mannai and Madai, was recovered by the natives and not by trained observers.

The challenge and frustration of restoring the treasure are the result of the conditions under which the find was made. We are faced with contradictory hearsay evidence and conjecture as to its findspot, arrangement, and contents. Thus, reconstruction of the treasure depends first upon reconstructing the stages of its recovery and the events that followed.

The French architect and scholar André Godard was Director of Antiquities for Iran when the treasure was found. The treasure had already been torn into shreds by the time he located the source of the objects appearing on the market, but he was able to photograph a large part and to recover a portion of that for the state. The measure of his success is the magnificent collection in the "Treasure Room" and storage vaults of the Archaeological Museum in Tehran. But hundreds of fragments escaped him and were sold worldwide.

Godard made the first assessment, suggesting that the treasure was the personal wealth of an early Mannean lord, which he had hastily gathered in a bronze tub and buried when the kingdom was threatened by an Assyrian advance. The worst fears of the anonymous prince were realized, Godard speculated, and Ziwiyeh fell to the Assyrian army. The cache was never recovered by its owner who, presumably, was slain in battle. The Assyrian annals narrate the progress of several invasions of Mannean land, naming among the embattled strongholds of the Mannai a *Zibia,* which well may be modern Ziwiyeh.

These suggestions could only have been confirmed by careful excavation of the site. However, the treasure hunt around Ziwiyeh continued at an accelerated pace after the financial success of the initial discovery. Added to the hit-and-miss scavenging, which is to be expected when the smell of treasure is in the air, was a methodical search of the hill by an antiquities dealer who had obtained a commercial license for the purpose (such permission is no longer granted). When archeologists finally examined the site, they found the area thoroughly dug; no hope remained of finding the undisturbed archeological context of the treasure. Indeed, almost every villager queried as to the location of the discovery pointed to a different place. An American team under the direction of Professor Dyson, of the University of Pennsylvania, took a few weeks off from its work at a nearby site to examine the hill of Ziwiyeh in 1964. An ancient, crumbling structure on the hilltop was inspected and some brief prospecting accomplished. This cursory examination suggested that the hilltop had been occupied during the last three-quarters of the seventh century B.C. But we do not know if there is a connection between the building and the treasure. Given these confusing circumstances, we are forced to place an unnecessarily large burden of proof on the evidence of the treasure itself.

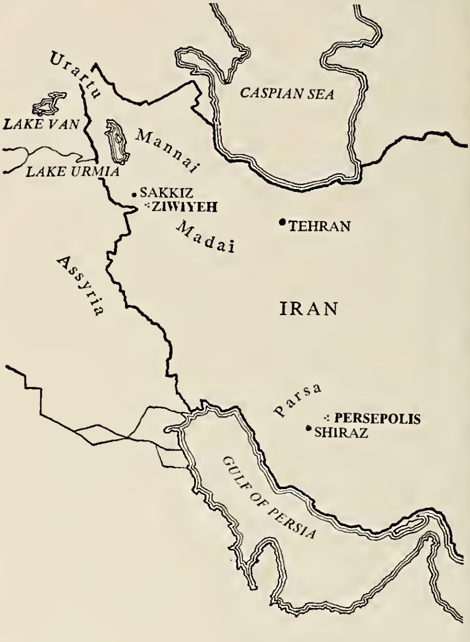
What were the original contents of the treasure? The answer must be disappointing: we are not sure. Godard's first report, the earliest record we have,

Beaten gold ornament from Treasure of Ziwiyeh depicts an eagle-griffin, anticipating spirit and style of those at Persepolis (p. 27).

mentions richly ornamented gold plaques, some massive gold jewelry with sculptured animal decoration, pieces of decorated dagger sheaths, some lion and griffin ornaments of beaten gold, a few delicately engraved horse-trappings of silver, and many fragments of finely carved ivory. Many more items have turned up subsequently that are either the severed parts of the gold and ivory pieces mentioned by Godard, or are so close in style to his objects that they must belong to the original treasure. Fragments of a rim flange and two ribs, distributed in collections in Tehran, Paris, New York, Brussels, and Seattle, are all that remain of the bronze tub that was said to have held the treasure. These bronze pieces are engraved in a freely sketched style with groups of local dignitaries in spotted fur robes and high-laced, turned-up boots bringing token offerings to a chieftain dressed in the Assyrian manner, followed by his similarly attired bodyguard. Here we have not only a token anticipation of the long rows of tribute bearers that will be carved at Persepolis, but also, perhaps, portraits of early Medes or Manneans. The original size and shape of this bronze tub can be accurately estimated from the preserved fragments. Squared at one end and round at the other, with the rim, bottom, and side walls securely riveted together, it is a copy in almost all details of tubs that had been previously excavated at the Mesopotamian city of Ur. There they were used as coffins, still preserving the skeletal remains and funerary goods when found.

This coincidence raises the question as to whether the Ziwiyeh tub might have served as a coffin. It is very possible that it, too, once held the crushed remnants of a skeleton that the villagers, in their haste to recover the valuable gold, ignored. Having no commercial value, barely distinguishable from rubble except to the trained eye, the bones were never recovered. The gold and silver may have been the expensive finery that the dead prince had buried with him, a standard practice in ancient burial rites. The style and the type of objects composing the treasure support this explanation.

A solid gold chape that once decorated the bottom of a scabbard is ornamented with two facing, catlike animals; some tiny beaten gold ornaments that were sewn on clothes and equipment are made in the shape of kneeling rams; and a heavy gold bracelet is made of a notched ring that terminates in rams' heads. These objects are characteristic of an art style that was in vogue among the nomadic shep-

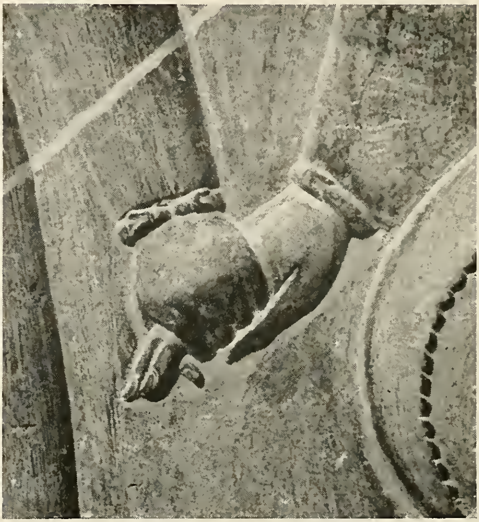


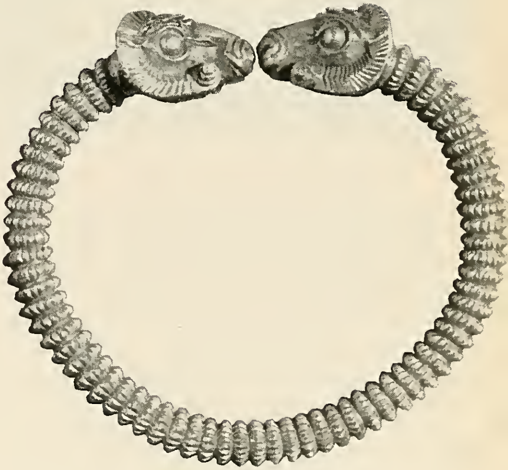
Persepolitan figures clasp hands adorned with horned animal-head bracelets; at bottom, gold bracelet from treasure has same design.

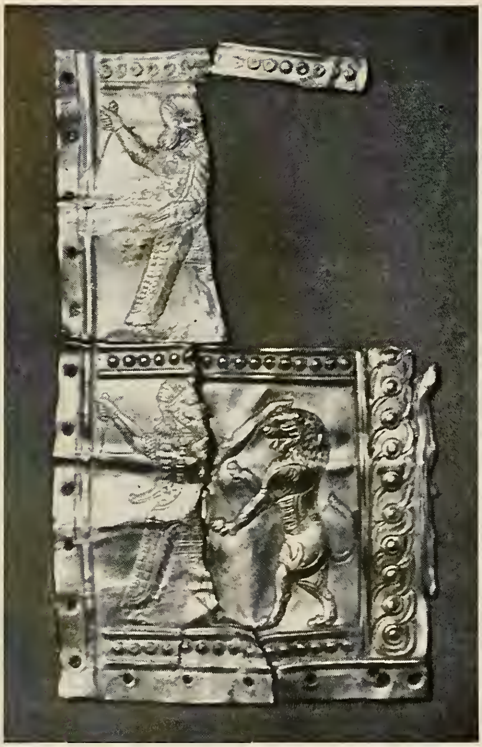
herds of the south Russian and Asiatic steppes. Many of the tombs of the nomadic chieftains have been found in south Russia, on the northern shore of the Black Sea, and particularly in the district of the Crimea. Under a high mound of earth, or *kurgan,* the dead prince would be interred with his jewelry, armor, weapons, horses and their trappings, household furnishings, and sometimes women or slaves. This variety of objects is strikingly similar to that of Ziwiyeh. Thus, there is good reason to consider that Ziwiyeh was not a buried treasure, but rather a princely Median-Mannean tomb.

While many of the ivories from Ziwiyeh formed decorated boxes and containers, some were made to be inlaid into larger objects, probably wooden couches and tables. Spearheads, arrowpoints, and metal horse-trappings attributed to the treasure would be inappropriate to a secret cache, but quite proper furnishings for a tomb of a warrior prince. The dead man was probably laid to rest in his jacket of gold ceremonial armor, of which we have several fragmentary remains. The armor was composed of two gold trapezoidal plaques sewn on the front and back of the jacket. Two leaf-shaped gold plates, similarly decorated with rows of fantastic beasts, are known from their torn remnants. We can identify them as decorative shoulder plates on the basis of some bronze armor found at another Iranian site. Around the neck of the deceased, worn as a badge of rank, hung a gold-embossed crescent. This gorget had been torn into more than twenty pieces, but Godard was able to rescue and restore almost the entire plaque complete with its gold wire suspension loops. Tiny hammered gold ornaments, shaped like crosses, flowerlets, rosettes, and animals, an inch or less in size, were sewn to the prince's cloaks. With gold scabbard, massive bracelets, and colorful robes, he must have presented an impressive figure, in death as in life.

While these personal items, along with the noble's arms, would have been placed in the coffin, the larger objects must have been set about the burial chamber. A few bronze fittings attributed to the treasure may have come from a chariot. Unfortunately, as the historical importance and reputation of the treasure increased, so also did the list of its contents. The label of Ziwiyeh has been unceremoniously attached to works of art from a variety of sources that gained the new designation as they passed from hand to hand. Queries made of dealers and collectors turn up "Ziwiyeh" pieces of most







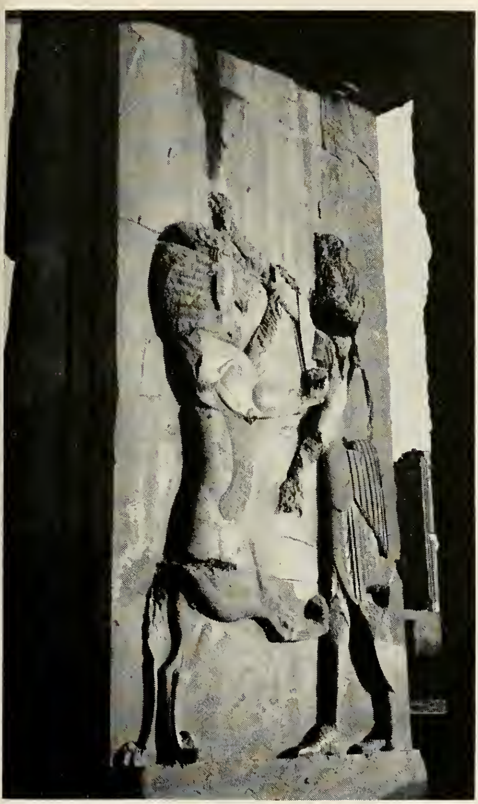
curious form. The obvious imposters can be quickly eliminated, but others it is difficult, if not impossible, to label with more than reasonable assurance. Thus, we have several pottery jugs and vases claimed for the treasure, but there is only hearsay evidence as to their origin. What began twenty years ago as a hoard of between fifty and fifty-five fragments has slowly grown to several hundred. It is a strange treasure hunt, indeed, where the size of the treasure increases with the length of the search.

A word about the art style of the objects from the treasure is appropriate. As mentioned, some of the objects bear striking similarities to gold work of the Eurasian nomads. These brilliant horsemen frequently raided settled areas, carrying back to their isolated encampments anything portable and of value. In the seventh century B.C., they burst through the Caucasus, ravaged western Asia, and, according to tradition, ruled there for almost a generation. The Medes and the Manneans had ample contact with these Scythians, or *Ishguzai* as the Assyrians called them, and such contacts brought about the interchange of art motifs. The ivory carvings are immediately recognizable as under strong Assyrian influence although there are slight differences that suggest they are the work of local craftsmanship rather than importations from the West. Other objects reflect the complicated international scene of the eighth and seventh centuries B.C., showing characteristics that ultimately derive from Syrian, Phoenician, western Iranian, and Urartean sources. Apparently the owner of the treasure dealt with highly skilled craftsmen who were acquainted with the products of the best craft shops of Asia.

While it is impossible to pin down the exact date of manufacture of the objects forming the treasure, or the date of its burial— the two dates could be separated by a few or many years—style and character suggest a period antedating the Persian Empire by several decades, probably in excess of a century. Hence, the treasure, with its incorporation of various unassimilated style traits, marks an early stage of the ivory and metalworking tradition that reached its culmination at Persepolis. A few obvious comparisons illustrate this point. A narrow gold strip from Ziwiyeh is divided into two columns of squares that hold the embossed design of a prince engaged in ritual combat with a rearing lion. The same motif is carved on the doorjambs at Persepolis. There the king slays lions and other monsters of the imagination, but always with the poise and sense of certainty of outcome that mark the Ziwiyeh gold. We can but offer guesses as to the meaning of this ceremonial sacrifice: the prince as the gods' surrogate vanquishes the demons of darkness and the lie, or the animal mastery symbolizes the all-powerful authority of the king under the aegis of Ahura Mazda, or the king who brings order to the nations of the world destroys chaos.

The eagle-griffin, a composite beast with the body of a lion and the wings and head of an eagle, frequently appears in Persian art, particularly majestic as the crowning element of the tall columns. Although monstrous in scale, by comparison, it is clearly the same beast in spirit and detail that is made of beaten gold at Ziwiyeh. Two iron-bladed short

On fragments of Ziwiyeh gold plaque, left, outcome of prince's fight with lion is assured in this ceremonial motif, repeated at Persepolis on sculptured doorjamb, below.



swords, or daggers, from Ziwiyeh are richly decorated, one with a solid silver pommel, the other with a varicolored limestone handle overlaid with silver foil. The blades are now badly corroded but once they were thrust into the type of scabbards worn by the Medes at Persepolis. That the treasure held similar scabbards is proved not only by fragments of gold plating, embossed with animal designs and folded into a flat tube, but also by the cast gold chape, mentioned before, which shows the type of animal designing represented on the Persepolis scabbard chapes. A finely carved stone macehead from Ziwiyeh does not have its direct counterpart at Persepolis, but the double birds' heads carved on it are reminiscent of the decorative elements on the equipment of the Persian and Median guards.

The members of the Persepolitan court are elegantly attired in earrings, torques, and bracelets. The burial at Ziwiyeh preserved just such costly golden jewelry. Two identical, heavy lion bracelets made of superimposed strips of gold were found at Ziwiyeh and are now separated, one in Tehran, the other in New York. The open side of the bracelet is capped with snarling lions' heads, one fastened on with a pin so that it could be removed to fit the loop of gold about the wrist. On the back of the bracelet are two sets of lion cubs, masterpieces of the jeweler's craft. Another gold bracelet with sprightly ram's head terminals is an antecedent of the animal head bracelets worn by the Persepolis figures. But there is nothing in the carved stonework to prepare us for the dainty "gauntlet" found at Ziwiyeh. Made of fine gold braiding woven into a network pattern, it was worn over the hand, fastened around the wrist, and secured to the fingers by five gold rings of which three still remain attached. The piece is absolutely unique in the ancient world, although there has been a current revival of the style in the costume jewelry shops where it is called a harem bracelet.

I have said that the importance of the Treasure of Ziwiyeh lies in the fact that it is a tangible, if fragile, link between the Persian Empire and its ancient heritage, about which we know so little. At the least, the treasure confirms what historians well knew, that the magnificent art of Persepolis did not spring full blown from the workshops of Darius and Xerxes. Rather, it slowly developed under the tapping hammers of goldsmiths working in the dimly lit cubicles that lined the ancient *souqs* of Mannean and Median villages, as do their modern counterparts in Oriental bazaars. We need to know much more about these dimly perceived people at the source of a great tradition. Such information will eventually come from controlled excavating in the provinces of Azerbaijan and Kurdistan. In just the past ten years American and Iranian archeological teams have had spectacular success at such northwestern Iranian sites as Hasanlu and Marlik. But, as of this moment, the Treasure of Ziwiyeh remains unique in its specific contribution to the prehistory of the Persian Empire, which might have held the world and given our Western civilization a far different cast had it not been for the audacity of a few Greek city-states.

The Royal Fleece of th

Once reserved for Inca royalty, the fine wool of the vicuña is now so highly prized internationally that the animal is threatened with extinction

by Nancy Flowers

"At this moment there is no present more acceptable to a Turkish bashaw than a piece of fine Vigonia cloth," wrote the English traveler William Walton in 1811. Almost 150 years later. the prestigious value of a vicuña coat was brought home to the American public when Sherman Adams, special assistant to President Eisenhower, accepted one as a gift from an industrialist, causing a major political scandal. Today vicuña coats sell in New York for about $750 and up. Clearly, it remains one of the most coveted symbols of wealth and status. Fleece from this graceful, wild cousin of the llama produces the finest, most costly, and rarest wool known.

Because of the beauty of its wool, the vicuña ranks high on the list of animals threatened with extinction. In the days of the Inca Empire vast numbers of vicuñas grazed the high pasturelands of the Andes. But for almost four centuries after the Spanish conquest. thousands were slaughtered yearly for wool and meat. Today they are almost gone. Peru's vicuña population was recently calculated at not more than 15,000, a precipitous decline from an estimated 250,000 about fifteen years ago. and there are even fewer left in Bolivia.

At present Peru has two specially protected areas for vicuñas—a reserve for wild vicuñas at Pampas Galeras near Puquio and a ranch near Puno for domesticated vicuñas

ndes

oundup at Cala Cala ranch in Peru. erdsmen drive vicuñas from pasture to rral to apply medication.

—and the Bolivian government has plans to set up a reserve near Potosí.

But extreme and immediate measures are required to save this rare animal, for its wild status (except for those recently domesticated in Peru) means that its fleece is not shorn, but is obtained from the skins of hunted animals. One English mill that specializes in exotic fabrics has been using two to three tons of vicuña wool a year—this represents at least 4.000 dead animals. It is apparent that nothing short of a worldwide ban on trade of its wool will save the vicuña from extinction. The cloth. while woven in Britain, is mostly exported to Japan and the United States, which have no restrictions to prevent its import and sale.

Conservationists in Peru and elsewhere protest this situation and have been trying for some time to persuade the governments of Britain and the United States to prohibit the import of vicuña wool. Peru and Bolivia recently announced a bilateral agreement placing a strict ban on its sale and export. Since these are the only two producing countries, it is obvious that any vicuña wool on the world market will have to get there by illegal means. But as long as there is a profitable market for vicuña wool, the illegal shooting will continue. The animals are often hunted by poachers using jeeps and high-powered rifles. Rangers and other authorities report that the hunters' first target is the band male. Once he has been killed, the leaderless females become confused and mill about helplessly instead of continuing their flight; then they and their young are easily shot. When alarmed, the band male gives a loud, whistling cry and herds his family away from the source of danger, bringing up the rear and, if necessary, nipping the rumps of the young to make them move faster. At full gallop, with necks thrust forward almost horizontally, vicuñas are among the fleetest of animals. Their speed has been clocked at 30 miles an hour.

Accompanied by his family of several females and young, the band male defends a distinct territory, chasing off encroaching families and troops of young, unattached males. The size of a territory depends largely on the abundance of forage in a given area. Carl B. Koford, who has written the only description of vicuña habits based on a long period of field study, observed and mapped territories ranging in size from 20 to 115 acres. At the high altitudes of vicuña habitat, the puna may be quite arid, and the vicuñas graze on the lusher grasses near streams. When necessary, they can find sustenance in areas that seem almost completely barren, their sharp incisors helping them to nibble close to the ground.

A source of water is important on

vicuña territory, and often the boundary between territories is formed by a running stream. Other boundaries are not marked by a feature of land, but are invisible lines established by repeated challenges, advances, and retreats.

When a resident male becomes aware of encroachment on his territory by a group of young males, he makes an elaborate display of belligerence, placing himself between his family and the intruders and posturing aggressively, with head held high and ears and tail erect. If his last warnings fail, he attacks says Koford: "the aggressive male chases one or a few individuals at a time. He may take only a few steps toward them, or make short dashes or feints at attack. But again he may chase one for several hundred yards, through many sharp dust-throwing turns, giving high wavering screeches from time to time and hoarse growls when pursuit is close. Although the male appears to be in deadly earnest in these chases, he rarely touches his quarry."

Vicuña honor is normally satisfied by this display of brinkmanship, and the male usually returns to graze with his family. During his observations, Koford witnessed only two actual fights, which consisted of wrestling and biting, accompanied by loud grunts and squeals. The duel, however, seemed to result in no more damage to the antagonists than the tearing out of a few mouthfuls of wool.

Vicuñas must also compete for forage with the livestock of the Indian villagers. The puna is far from deserted; it is, in fact, quite densely populated—67 percent of Peru's population lives in the highlands. According to a bulletin of Peru's Veterinary Institute for Tropical and High Altitude Research, the puna is already overgrazed. Most Peruvian livestock is raised in the highlands on natural pasture—85 percent of the cattle, 99 percent of the sheep, and all the llamas and alpacas. These animals compete for forage with the remaining vicuñas.

By agreement with the villagers, Pampas Galeras, the 6,000-acre vicuña reserve, was established two years ago by the Peruvian Forest and Wildlife Service on land belonging to the Indian community of Lucanas. About 900 vicuñas share the range with 2,000 sheep and 300 llamas and alpacas belonging to the Indians. Protected by patrolling rangers, the bands of vicuñas graze peacefully near the livestock. They have become relatively tame, hardly bothering to raise their heads to stare at vehicles passing along the road. They are much more wary of people on foot, and at the sight of an approaching man, the male gives his screech of alarm and the band dashes off.

Vicuñas make no attempt to defend their territory against grazing animals of other species. When disturbed by livestock they simply retreat in search of other pastures. But llamas, alpacas, and sheep eat essentially the same kinds of forage as vicuñas. Jim Yoakum, a wildlife biologist who recently spent three months in Peru on a special advisory mission to the Peruvian Forest and Wildlife Service, points out that if the vicuña is to be preserved as a wildlife resource, range management is at least as important as the control of depredation by hunters. The very presence of man and his domestic animals introduces serious competition. If the indigenous wildlife is to survive, some attempt must be made to restore and maintain at least part of the natural habitat.

Curiously enough, the ancient Peruvians were perhaps the first people to have a nationwide system of what today would be called wildlife management. This system was described by the half-Inca chronicler, Inca Garcilaso de la Vega, who was born in Cuzco in 1539, seven years after the first Spaniards landed in Peru. His father was the Spanish governor of Cuzco, his mother an Inca princess. Garcilaso heard the story of the fallen empire from his maternal uncles, who told him of the great *chaco* ("the royal hunt") that was held every year in a different province of the empire.

Apart from the great hunt, the killing of wild game was forbidden throughout the empire, as the Inca

cuñas are difficult to domesticate, partly
cause of strong territoriality. Herds
the ranch failed to breed for eighteen years.

authorities were of the opinion that the attractions of the hunt would distract the common people from their principal task, agriculture. As a result of this decree, Garcilaso tells us, the animals and birds became so tame that they would enter the Indians' houses. The people of a province must have looked forward eagerly to the excitement and diversion of a royal hunt, as well as to the prospect of abundant meat.

Having chosen a time of year when the breeding season was past, the Inca and his nobles traveled to the province where the *chaco* was to be held. Some 20,000 Indians of the district were assembled and divided into two lines of beaters, enclosing a circle of land about 50 miles in circumference. The shouting beaters flushed the game and drove all that were caught within the circle toward a flat, open plain that had been chosen for the culmination of the hunt. As the ring contracted, the beaters, now three and four deep, formed the human wall of the corral where all the wildlife of the area was massed.

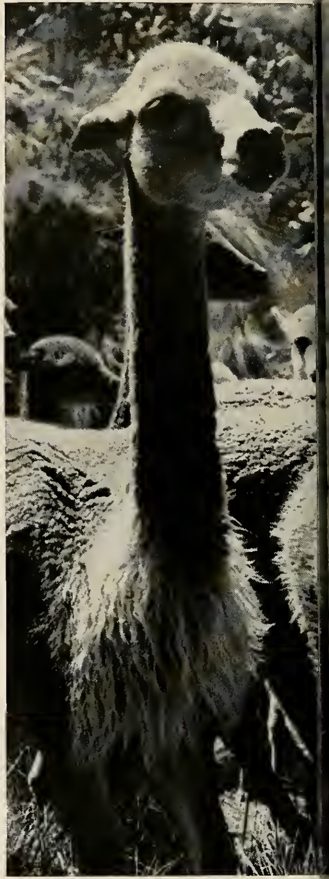
From a nearby hilltop, out of the way of the great clouds of dust that rose from the plain, the Inca and his curacas directed the hunt. First the predators—the ocelots, pumas, bears, and foxes—that had been trapped in the great roundup were killed.

Of the deer, the Inca ordered the does released, as well as the largest and finest of the breeding stags. The rest were killed and the meat shared among the people. Then the vicuñas and guanacos were tackled by hand or with bolas; their wool was shorn, and then they too were released. The royal scribes recorded the result of the roundup with the quipus, the system of knots in twine with which the Incas kept their statistics. They noted, by sex and species, the number of captured animals, the predators as well as the "useful" game, so that the Inca might know at the time of the next hunt whether or not the game had increased in number.

The coarse wool of the guanacos was distributed to the commoners, but the delicate fleece of the vicuñas was for the Inca, who shared it only with the nobles of royal blood. The virgins of the Temple of the Sun spun and wove vicuña cloth for the royal clothing. To others it was forbidden under pain of death.

The provinces where the royal hunt was held were rotated so that it fell in the same district only once every four years. This allowed time for the vicuñas to grow a full coat and for the game to multiply.

"In this order," wrote Garcilaso, "the Inca emperors hunted their lands, preserving the game and improving it for the future, and delighting themselves and their court, and to the profit of all their vassals, and they held the same order through all their reigns. The Incas said that



Capable of racing along at 30 miles an hour, the vicuña relies on its speed to escape predators. Man is its greatest threat.

the wild cattle should be treated so that it should be of as much profit as the tame, for Pachacamac and the Sun did not create it to no purpose."

The *chacos* did not come to an end with the Spanish conquest, but they soon became nothing more than a method for slaughtering huge quantities of game. The vicuñas captured were no longer shorn and released, but simply killed and skinned. As late as the middle of the nineteenth century the German naturalist von Tschudi tells of a *chaco* he witnessed in which thousands of animals were butchered.

The viceregal government made a few attempts to limit vicuña hunting, but the laws passed remained a dead letter. Hardly more successful, to judge from von Tschudi's account, was the decree passed by Simón Bolívar, soon after the liberation of Peru, strictly prohibiting the killing of vicuñas in the newly independent country. Bolívar added another clause offering a reward of one peso to anyone who could produce a herd of ten domesticated vicuñas.

The idea of taming vicuñas was not a new one. The llama and alpaca were domesticated, it was reasoned, so why not their valuable cousin? The Jesuits, before their expulsion from South America, are said to have assembled a herd of 600 tame vicuñas.

There have been many instances of tame vicuñas living more or less contentedly in captivity. There is no particular difficulty in taming a vicuña if it is captured young enough, and it can be easily bottle-raised on cow's milk. An infant vicuña is one of the most charming pets imaginable.

At Pampas Galeras reserve, Normita, a young vicuña, was very much part of the family of one of the Indian rangers. She had been bought for 100 soles from a villager who found her wandering alone on the pampa, having apparently lost her mother. Normita behaved in many ways like an affectionate puppy. Legs doubled neatly under her, her head bobbing as she cautiously observed every nearby movement, she sat close to the ranger's wife and sister as they spun by the doorway of their house.

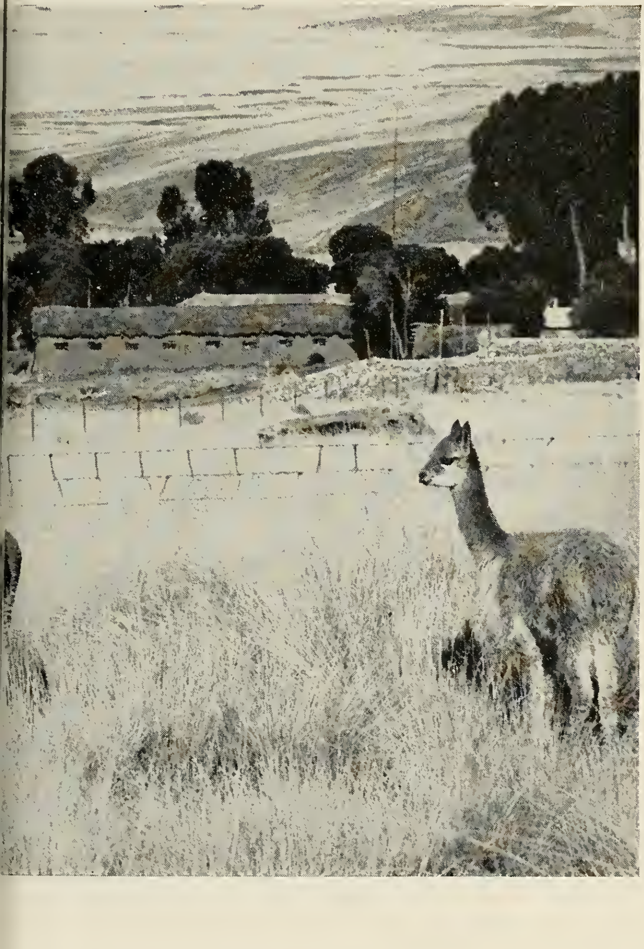
Tame vicuñas, however, become less tractable as they grow older. Once they are of breeding age they will escape into the wild if possible, and if held in captivity, will usually refuse to mate even if there is a vicuña of the opposite sex available. In fact, if too closely penned with other vicuñas, they will often bite and kick.

The Peruvian rancher Francisco Paredes had, before his recent death, progressed further than anyone previously toward domestication of the vicuña. Nearly fifty years ago at Cala Cala, his high-altitude sheep ranch near Puno, he captured ten young vicuñas that became the nucleus of his herd. Hand-raised by him and his wife, they remained tame enough when grown to come to him when he gave a special whistle signal. As time went on he acquired more young vicuñas until he had a good-sized herd, all accustomed to human handling. They had the freedom of a fenced-in pasture large enough for them to develop the social habits that distinguish the vicuña in the wild. Nevertheless, it was not until eighteen years after the herd was started that the first ranch-bred vicuña was born. After that the vicuñas started to breed freely, and the herd now numbers about 800, all ranch-born.

Paredes also succeeded in crossing the vicuña with the alpaca to produce a hybrid known as the paco-vicuña. He did this by raising the intended pair together from infancy. The paco-vicuña has promising commercial possibilities, for the wool of this animal is only slightly less fine than that of the pure vicuña, and there is a lot more of it. The paco-vicuña produces a fleece of three to five pounds, compared to less than a pound for the vicuña.

At Cala Cala I watched a modern version of the Inca *chaco* when the ranch vicuña were brought down into the corral for treatment of a kind of mange that has become endemic among llama species. Early in the morning the Indian herdsmen, some on foot and some on horseback, set out from the ranch house to

icuñas graze on lush pasture at Cala Cala,
ut in the arid Andean highlands wild
icuñas manage to survive on sparse, low grasses.



gather in the vicuñas, which were grazing at the far end of the pasture. They disappeared over the hills and for half an hour all was quiet. Finally we saw a galloping line of vicuñas along the top of a ridge, silhouetted against the deep blue sky. The herdsmen appeared behind them. shouting and waving them on. But suddenly, as if at a signal, half of the fleeing band wheeled in their tracks and doubled back into a valley. Emma de Paredes told me that the vicuñas know very well when they are about to be penned into the corral and will use every tactic of speed and agility to elude their pursuers.

Other groups of vicuñas were driven down over the hills, and gradually all were herded toward a narrow ravine that led to the corral.

Once in the corral the vicuñas crowded on one side, whistling in alarm as the herdsmen picked out the animals to be treated. One by one, they were thrown to the ground and medication was applied to the cracked skin. Only one or two were found to be infected, as a yearly dipping keeps the disease under control. The corral gates were opened and the vicuñas ran back to freedom.

The vicuña responds well to the protection of man, something it has seldom enjoyed since the fall of the Inca Empire. Without this protection the vicuña is probably doomed to vanish; to become only a memory and legend of beauty on the high puna of the Andes.

Arctic Walk

Amid the vastness and magnificence of Alaska's Brooks Range lies a smattering of oil drums—a hint of things to come, like Torrey Canyons and Santa Barbaras

by John P. Milton

Between July 22 and August 29, 1967, Kenneth Brower, Steven Pearson, and I walked from the southern foothills of Alaska's Brooks Range, across the high mountains of the Arctic Divide, then down across the open tundra to the Barter Island DEW-line station, on the Arctic Ocean—a transect, from south to north, across the Arctic Wildlife Range. Much of our route had no record of earlier exploration. Excerpts from my journal of this trip are contained in the following pages.

On this 300-mile walk, my own purpose was to blend into the soul of these Arctic mountains and plains, to sense the moods and manifestations of the land. Our journey was a lesson in solitude, a vanishing experience in an age when most of mankind is crowded, yet lonely.

In July, 1968, a year after our walk, the Atlantic Richfield Company and Humble Oil and Refining Company announced the discovery of "one of the largest petroleum accumulations known to the world today" along the Arctic slope of the Brooks Range. This field may be equal to from one-tenth to one-fifth of the oil reserves of the entire North American continent. Don Randall, an oil expert and geologist, commented shortly after the announcement: "This discovery . . . will open the door to a vast and fabulous play stretching from Alaska across the Canadian Arctic."

Over the months since the discovery, a fever of activity has spread throughout the North American Arctic, particularly concentrated at Prudhoe Bay—located on the Arctic coast about 300 miles north of Fairbanks and 150 miles southeast of Point Barrow. It is here that the major strike was made and where most of the drilling is being done at present; over much of the rest of the Arctic, plans for new exploration are rapidly forming. On September 23, 1968, *The New York Times* reported that recent seismic surveys have identified several good prospects for drilling in Canada's high Arctic. They also stated: "In a year or two, American and Canadian oil companies may pour survey and drilling crews into the northwestern corner of Canada." The play has begun. The latest rush for black gold is on.

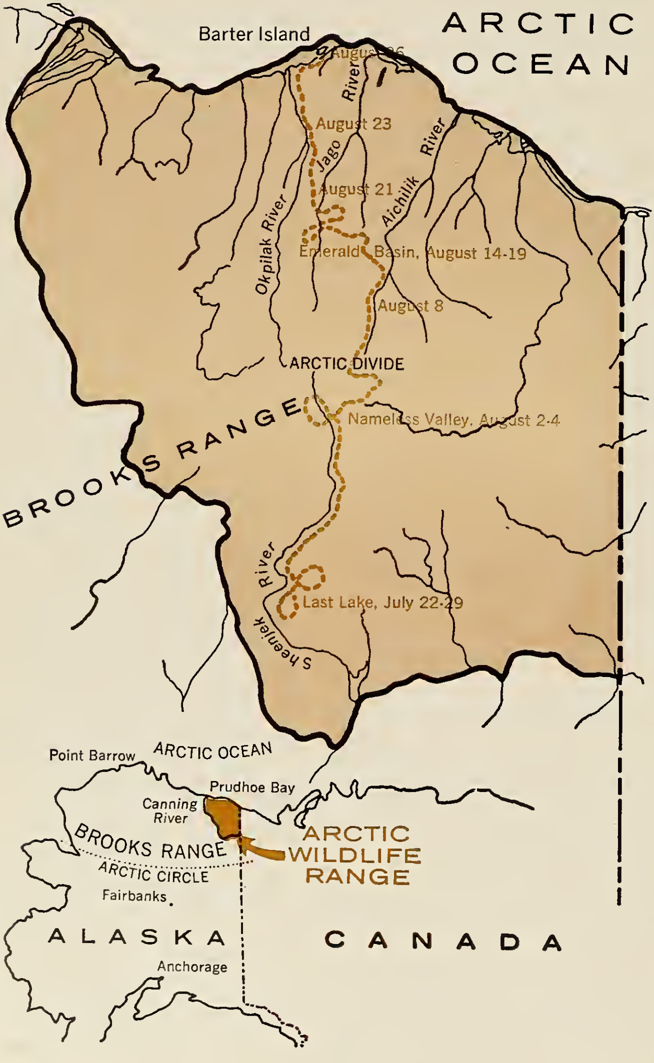
Climatic and transportation problems, however, are already posing some difficulties. In Alaska there are no roads or major ports north of the 600-mile Brooks Range, which runs across the northern half of the state. A decision has already been made to run one pipeline over these mountains to the southern coast of Alaska. There also have been proposals for a second pipeline to cross from Prudhoe Bay into Canada's Mackenzie Delta region, where oil could then be shipped up the Mackenzie River or through the Northwest Passage to the eastern United States. This would allow oil companies to avoid the restrictions of the Jones Act, which requires that all interstate shipping must be on U.S. carriers. A port in Canada would allow use of less expensive foreign shipping.

In 1960, Secretary of the Interior Seaton established the 9-million-acre Arctic Wildlife Range in the rugged eastern Brooks Range. In size, the protected area is slightly larger than the state of Vermont. The reserve extends approximately 140 miles from the Arctic coast in the north to the foothills of the Brooks Range in the south. From the Canadian border forming its eastern boundary, the reserve runs 120 miles west to Alaska's Canning River. Only fifty miles west of the Canning River lies Prudhoe Bay and the major locus of the oil discovery.

The Arctic Wildlife Range is the largest single federal biological reserve in the country. It is the only protected wilderness area in the mountains and tundra of Arctic Alaska; the home of moose, lynx, hares, caribou, polar and grizzly bears, Dall sheep, wolves, wolverines, Arctic foxes, and many other animals. The necessarily large size of the reserve has helped insure that this virtually undisturbed portion of Alaska has a high degree of biological self-sufficiency. All the major habitats typical of northern Alaska are found within its boundaries: taiga; Arctic mountains, rivers and glaciers; open tundra; and the ecotone between tundra and taiga.

Wilderness protection in the Arctic Wildlife Range may be endangered by the new oil discoveries at Prudhoe Bay. Should the Secretary of the Interior so desire, he could open the reserve to exploration and drilling. This would cause severe environmental damage, since, due to the Arctic's climate and abbreviated growing season, surface scars on the tundra, from only the occasional passing of vehicles, remain for dozens of years and often cause a cycle of accelerated permafrost melting and erosion. If the proposed pipeline from Prudhoe Bay into Arctic Canada is built, it would cut across the open tundra of the Arctic Wildlife Range to compound the damage done by exploration and drilling.

Dumping of oil drums by oil exploration parties has already marred the beauty of many parts of Arctic Alaska. Similar activity in the wildlife range would quickly shatter its wilderness mood, as would roads, camps, pipelines, oil rigs, buildings, and other repulsive accouterments of oil technology. On the open plains of the Brooks Range's north slope, even minor irregularities in the landscape are visible for great distances. The disruptive influence of a single tower, for example, would extend over an area of many hundred square miles.


ARCTIC OCEAN
Barter Island
August 26
River
August 23
Jago
River
August 21
Aichilik
Okpilak River
Emerald Basin, August 14-19
August 8
ARCTIC DIVIDE
Nameless Valley, August 2-4
BROOKS RANGE
River
Sheenjek
Last Lake, July 22-29
Point Barrow
ARCTIC OCEAN
Prudhoe Bay
Canning River
BROOKS RANGE
ARCTIC CIRCLE
Fairbanks
ARCTIC WILDLIFE RANGE
ALASKA
Anchorage
CANADA

A fire hazard could also aris
particularly along the range's sout
slope. A fire that seriously damage
the region's lichens would prove particularly devastating to caribou
These plants are the basic food fo
caribou and often require up to 12
years to regenerate after burning.

There is still another danger t
both terrestrial and marine ecosystems posed by problems of oil pollution. Inevitably there will be problems of liquid waste disposal int
rivers and marine waters, particularly if any refining is done alon
the Arctic coast. The greater pollution threat, however, comes from th
potential danger of oil spills fron
tankers or leakage from any offshor
wells that may be drilled. A disaste
like the wreck of the *Torrey Canyon*
or the recent Santa Barbara oil leal
would have severe effects along th
Arctic shores of Alaska and Canada
During the few months when thes
coasts are relatively free of ice, th
main ice packs are never far from
shore, leaving only narrow strips o
open water. An Arctic oil slick would
be concentrated along the shorelin
by the ice pack, allowing little chanc
for dispersal, and the cold wate
might further inhibit the activity o
microorganisms important in breaking down the oil. The impact on the Arctic's rich marine plankton, fish, and mammals, and upon the extensive summer habitat of many migratory waterfowl, would be tremendously detrimental. Also, what would be the impact on the Eskimo's way of life if the whales, seals, fish, and birds upon which they depend are depleted? In the current enthusiasm over oil in the Arctic, little, if any, attention is being given to these major environmental problems.

JOHN P. MILTON
March, 1969

Friday, July 21, 1967

After three days of rain and trip preparation in Fairbanks, we are about to leave for Last Lake near the upper Sheenjek River.

Our 250 pounds of gear are now loaded in the little plane that will carry us to our remote first campsite—Last Lake. For the next month or so—hopefully—we will see no other

Beaver, Sheenjek River

Ice cave

Ice-covered lake

Gravel bar

men. We will be alone, on our 300-mile hike, to take in the wilderness of the Arctic Wildlife Range. To our knowledge, no other men have made this south–north journey through the high mountain passes of the Brooks Range. From now on, our life will center on the immediate horizon. No media, no middlemen.

Saturday, July 22

We are here. My sense of space and distance are greatly expanded by this country. It is incredibly beautiful. The broad valley of the Sheenjek curves through a tumbled series of steep side valleys and slate-gray mountains practically barren of visible vegetation. The valley floor is green and lush, with numerous patches of open forest breaking up the grassland and wet muskeg. To the north, at the head of the Sheenjek, a band of snowy mountains reaches skyward between 6,000 and 7,000 feet. (At Last Lake the valley floor has an elevation of 2,500 feet.) Over all this, a wonderfully clear atmosphere lets the eye wander on and on, drawing it deeper into the hidden mystery of far valleys and mountain passes. The sun, revolving slowly in a great circle, casts a deep, warm glow over the wilderness. For only a few hours it disappears behind the northern mountains, casting a fiery sunset all "night" long. I cannot walk far in any direction without having to stop and look about me. We will camp here for several days.

Saturday, July 29

It's nearly midnight and I can still write by the evening light. We find abundant signs of wolf, lynx, Dall sheep, moose, grizzly, caribou, and smaller animals here. Ken reported seeing a yellow-haired porcupine that looked "just like a small bear. When I talked to him he faced me and wasn't afraid. When I came back for a second look, he grew suspicious and waved his spiny tail at me."

Ken and I sat until late in the evening watching and photographing the present two rulers of a little kingdom of beavers upstream. Probably the northernmost colony of beavers in this hemisphere. They splashed and whacked their tails noisily when we first arrived, but after that they seemed to quiet down. We sat still. The two beavers sliced wakes of liquid silver as they churned to and fro in front of us. Just once, the larger one—the male—overcame his fear enough to come almost to our feet. He lay still, flat tail slightly waving, peering up at us out of suspicious old-maid's eyes. Then, *whack*, and he was gone.

Yesterday, I walked south a mile to frozen "Ice Lake." The lake is cut across by a flow of clear water, which slices a serpentine course through bluish-white ice walls from eight to ten feet high. A small ice cave sheltered me for a few minutes when a storm passed over. The ice banks reached over me—not quit meeting. The inner walls, drizzling in their own steadier rhythm than the storm above, were neatly scalloped—as though by some fine craftsman's chisel. After the storm was over I left and plodded back across the brownish moorland to camp.

Friday, August 4

Today, exploring side valleys, we came to a very high, impassable cliff and talus slope that dropped steeply into a tributary of the Sheenjek. We

Brooks Range glacier

had to climb 800 to 1,000 feet over it to get by. But the view from the top was superb. The valley, lined by impressive ridges and peaks, curved slowly to the west. A river wound down the center, lined with gravel bars and willows gleaming from a patch of clear sunlight here and there. Up from the stream, the green valley bottom sloped gently to the brown grasslands and gray rock of the mountainsides. The whole valley seemed very special and secret. The knowledge that we were probably the first white men to set foot in it only added to the impression of a little world set apart.

These mountain valleys seem to have a strong personality, an individuality that sticks in the mind. And so it is here, in Nameless Valley. Arctic mountains are distinguished by an ever-present mood of darkness, cold, and snow. Winter is a constant, though usually hidden, companion during the short Arctic summer; the quickness of the summer only intensifies an awareness that here warmth is only a brief respite from cold, that light will soon be followed by a deep and much longer-lasting darkness. This mood dominates the land and every living thing in it. The mountains also know the cold of glaciers; the ice wedges carve their slopes and chip away the cliffs, leaving great cones of talus to pile up below. Summer is but a short, quiet interruption —a convenient punctuation to one more dark and wintry cycle.

Walking back to camp along a high ridge of rock in the valley cen-

Grizzly

Arctic lichen

, I was struck by the quality of this iderness: Tiny details like the its of red moss mixed with green rpeting; little mountain rivulets d the larger scale of grizzled moun-n slopes; the vast expanses of de valley; far, snow-flecked peaks, ouds, and sky—all are contributing ements. This is wilderness on a ale that the mountain men knew in r far west during earlier days. To ve the mood requires hundreds of iles of empty land and large expanses of unexplored territory. This ooks Range wilderness still has ese elements in abundance, and nposes upon you a need for self-liance.

Here is an atmosphere of nature at s untamed, uncivilized best. The ilderness stands on its own: free, ot propped by access roads, park ngers, interpretive centers, and regulations on use, as in the quasi-wilderness of our national parks. Here there is no prostitution of the freedom so essential to wilderness—and the quality of the experience reflects this.

pper Okpilak River

Tuesday, August 8

The hour is 10:00 P.M. and it is snowing steadily. We are camped at the junction of the two main headwater streams that combine to form the upper Aichilik River.

By five today we were all chilled, with freezing cold feet and hands. We set up camp in record time and stripping off our wet pants, followed by a change into warm socks, we plunged into the double cocoon of tent and sleeping bag. Dinner—freeze-dried pork chops and mixed sliced potatoes and vegetables—was cooked over the little portable stove in Steve's tent. That little stove has been doing very well by us ever since we crossed over the Arctic Divide; recently we've had no opportunity to build a wood fire (either no fuel or too wet) although today river willows reappeared, and had the weather been different, we might have. The stove has been burning for well over an hour on one filling (instead of the prescribed 50 minutes). After so many "4-man meal" food packages that would barely serve two, it's good to have some surplus at least with our cooking fuel.

My injured ankle was a little better today, although for the last two hours I was in almost constant pain while walking. I've noticed I prefer to walk either last or first and to have our group well spaced out. When in a tight group, I always tend to feel distracted by the sounds and movements of the others. Much better to wander as individuals, collecting our own feelings and experiences to be shared in the evening or at rest stops.

Saturday, August 12

In spite of Steve's and my ankle problems, we managed to cover another eight miles today between 2:00

Emerald Basin

Bull caribou

Brooks Range, looking south

Open tundra

and 7:00 P.M. The northern border of the Brooks Range is now quite near—and beyond that, open tundra.

Somehow, the tundra now seems to represent the major unknown for us. We worry about crossing the Jago River, but much more about traversing the tundra. Will blizzards hit? High winds? Is there enough fuel? Can we be sure of finding the right stream to follow in all that flatness? How will we know when to cut cross-country to Barter Island—lacking landmarks? Will the walking be all muskeg, tussock grass, and bog—or gravel bar and level grassland? Will our feet, legs, and general health hold out long enough to get us there? These are some of the questions we've asked ourselves while pondering the tundra. And so it must always be with any unknown challenge. Such questions are the springs of adventure.

An hour ago Ken strode into camp after some early morning hiking. From an overlook he spotted a medium-sized grizzly that came within 70 yards of camp, rose on his hind legs, then apparently caught our scent. He bolted up into a side valley, running continuously until out of sight. What is it that makes such a powerful beast run? Fear of the unknown? We are surely the first men he has ever smelled; but if he has no other animal to fear in his domain, why run from a new smell? No other animal can conquer the grizzly in his Arctic home, and it should be outside his experience to have to take flight. But he ran.

It is now nearly midnight, and I write by candlelight; the horizon to the north outside my tent is afire with a deep, reddish glow. The thermometer stands at 23° F. Inside the tent it is a warm 28 degrees.

Monday, August 14

Today has been magnificent. We've walked about eight miles, over two passes, and camped atop a wide, two- to three-thousand-foot-high plateau (which we call Emerald Basin) at the northern edge of the Brooks Range, near the junction of the mountains and the barren tundra stretching north to the Arctic Ocean.

On a mud bar in Green Willow Creek, I passed a line of wolf tracks, unusually large in size. Once they met and mingled with caribou tracks of about the same age. An encounter? What a free-ranging life for wolf and caribou up here; they are animals needing broad stretches of wilderness to survive—as did once the bison and plains wolf of our long-lost western frontier. In his inability to compromise with civilization, the wolf is almost entirely gone from the contiguous U.S. But here is the old wolf range on a vast scale, as before.

Earlier in the evening, a red sun settled down above Lone Mountain, and fog sifted in thickly from the tundra through a pass and sent out numerous fingers of white across the valley floor. The sun turned the top of the fog to gold and bathed the green valley in amber light. Sheer, snowy mountains looming over the scene turned rosy colored from flanks to summits, while ice formed in thin sheets of transparent crystal on the small pools between tussock grass. All the agony of injured foot and blizzard were worth these few hours of evening.

This land seems to be forever unfolding new surprises, both in weather and terrain. These two elements combine and recombine in an infinite variety of form and light. Who can say they have seen these Arctic mountains as they really are? —they are too changing and too varied. Each of us who has come here has lived but a part of the truth; tomorrow will not be the same.

Tuesday, August 15

About an hour after rising in the morning, which dawned clear and bright, Steve yelled "caribou!" I grabbed my binoculars, camera, the two telephotos, and was out of the tent. About a half mile away, two bulls lay contentedly in the snow. While Ken watched, Steve and I began to stalk them, got to within one-quarter mile of them, then sat down to watch and wait.

Slowly, the bulls got up from their resting place and grazed for a short hile between snow patches. Then, as ough curious to see what we were, ey began to trot directly toward us. ur cameras clicked madly. They assed within 30 yards, heads lifted roudly and their antlers still in vel- et. After passing us they nearly went rough camp—20 feet away from en, then on out into Emerald Basin.

riday, August 18

I now feel little desire to change y environment from Arctic wilder- ess to civilization. All of us have ow been here long enough to settle ompletely into our new pattern of fe. Although difficult, it has its com- ensatory comforts and the sharp oys of wilderness experience. At ach of our three main base camps, ast Lake, Nameless Valley, and now ere at the mouth of the Jago's moun- ain valley near the beginning of the undra, this sense of belonging, of a lace defining our normal life, has een particularly strong. But, during hose times when we've been on the nove day after day, then that nomad- sm seems to become the normal pat- ern of existence. How quickly man dapts.

And yet, over periods of time, de- iciencies in life appear—in either the vholly civilized life or a life con- tantly in the wilderness. It is a life pent contrasting and living alter- ately in both worlds that seems best o me. Indeed, the very words them- elves, "civilization" and "wilder- ess," require each others' existence o have real meaning.

When we go into wilderness we are consciously reversing a historical process whereby civilization has gradually acquired more and more power to manipulate and change the earth to serve man's own ends. But, as in the case of the "ring of power" in Tolkien's classic trilogy, power over nature carries with it a new curse; the newly found power more and more begins to control us and limit our choices. Despite the many new freedoms that advancing technology has brought us, application of each new advance involves us in an ever deepening web of causes and consequences that require considerable new limitations on older freedoms if we are to sustain the new ones.

Saturday, August 19

Today we climbed up to a long, narrow lake just west of the Jago River. An oil exploration crew had been there before us. The beauty of this lake is now diminished by the presence of over 20 scattered oil drums; the tattered ruins of a large, domed shelter; and litter of all kinds strewn about. Man's insensitivity to a wilderness landscape can be appalling. These scars will remain for a generation or more—yet the wreckage was littered about with no more thought for those who might follow here, than a group of monkeys let loose in a fine French restaurant would feel for the next day's patrons.

Fortune has provided for us in one way, however, for amid the litter we found tins of cooking oil and sugar and a pancake turner to allow us to turn out whole cakes. We also found a new frying pan handle to replace the one lost and a new teapot top to fill in for our badly battered one. We'd lost two forks and a cup—those also we discovered and took. Finally, I added a fourth plate as a luxury item to place our little stove on or to cut food in. All things considered, we had good scavenging. But I would rather forgo the extras and find a clean tundra lake.

Monday, August 21

After about two hours of walking this morning, the fog gradually and steadily lifted. Abruptly the tundra was transformed as the sun broke through to turn the earth to gold. It is almost impossible to describe the vastness and special beauty of this open tundra. I was struck by the absolute flatness of the northern horizon—we were able to see over fifty miles to where the coastal clouds began. On either side the warm, rich tone of the tundra rolled out in long, gradual waves of gentle slopes followed by broad basins. Behind us, to the south, the brown plains sweep up to the very edge of the granite peaks of the Brooks Range, decked with long white glaciers. The subtle shadings and gentle contours of the prairielike tundra seem strangely accentuated by the sharp, savage mountain topography and color. And tonight, another mood comes over the tundra as the sun sets and the land colors a deep burgundy.

This trip has helped sort out my existence. When I'm caught up in the

Yellow-haired porcupine

day-by-day turmoil of our complex society, it becomes difficult to separate the meaningful from the meaningless. On this expedition many of my problems—or what I saw as problems—began to take on new form and perspective. The relative simplicity of wilderness life cleanses you of numerous petty concerns that are so typical of our waking time in the civilized world. Out here goals are basic and obvious: good health, warm shelter, food, a fire, where to camp, where to walk, the enjoyment of your surroundings.

Abandoned oil camp

Wednesday, August 23

It is midmorning as I write in camp, and the sun is attempting to burn through the clouds. We will continue along the Okpilak River toward the Arctic Ocean. How simply and easily we have moved through this wilderness—and what a contrast to (I like to think) the cumbersome, ugly movements of the oilmen who tried to bring all of civilized life here with them, and succeeded most in scarring the land with oil drums: the symbol of their particular rape of the land. In the wilderness, man should move like a nomad, with the aim of leaving the least possible traces of his passing behind him. Here is the opposite ethic to Ozymandias: man is measured more by what does *not* remain, than by what does.

We have done well in abiding by this ethic, I feel; bits of paper are burned, our few small cans flattened and buried, our campfire stones scattered. All that remains is a patch of slightly flattened moss and grass, no more than a small herd of caribou or family of wolves would leave behind following a long rest.

Saturday, August 26

Morning came with a cold, damp fog still hanging over our camp. We ate a full breakfast of eggs mixed with what was left of last night's vegetables, and a meat and bacon bar. By the time we were through, the fog had lifted and the sun was shining. At 1:00 P.M. we broke camp and headed north. About two miles north of camp, we topped a rise—the Arctic Ocean lay before us!

Sandwiched between bright blue sky and sea, the brown tundra ende suddenly in a series of low cliffs ru ning on down the coast as far as w could see. The creek widened into small marsh and beach. We followe it. A series of barrier beaches an islands, the largest of which is Ba ter (site of a U.S. DEW-line station lay from a few hundred yards to se eral miles off the coast.

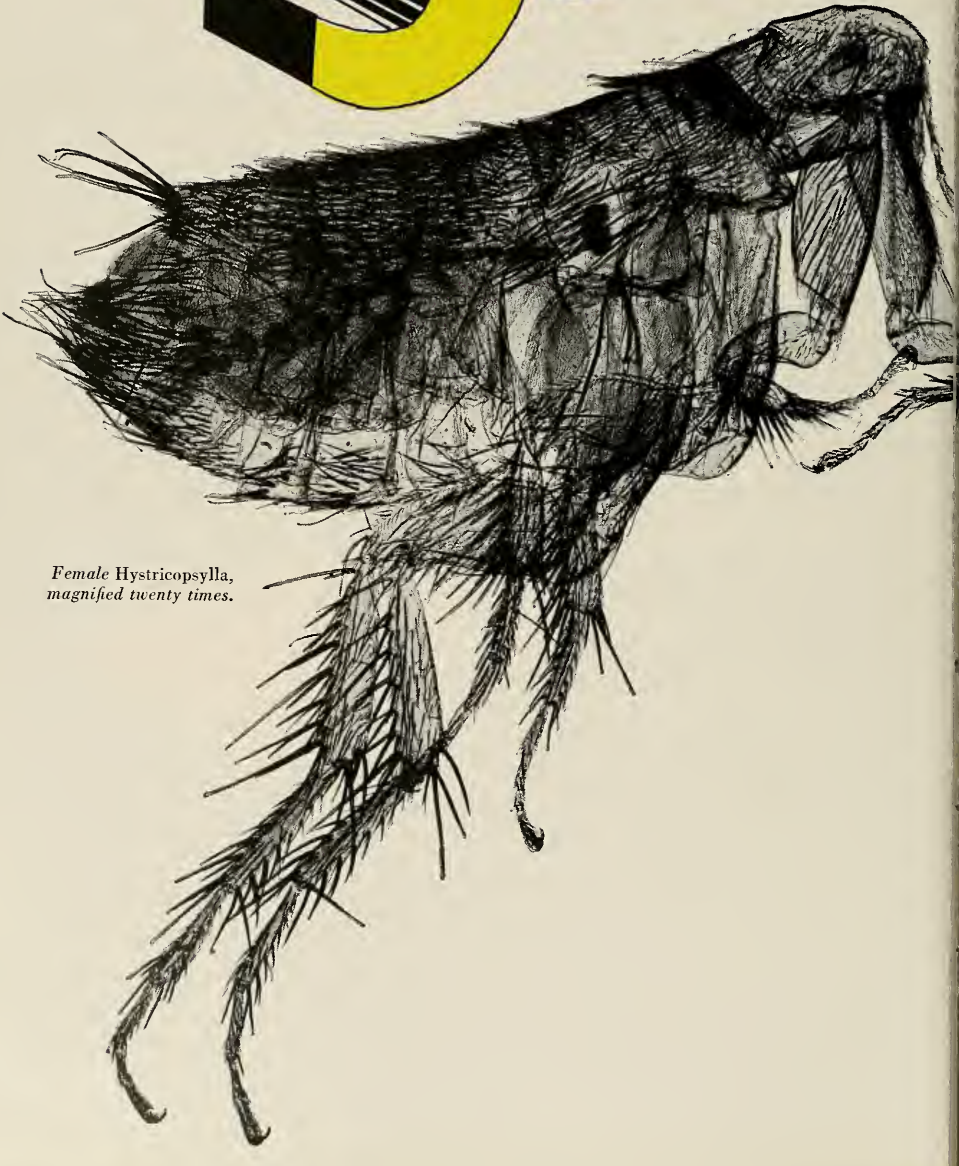
Camp, Nameless Valley

Far off to the north, the brillia white of several widely spaced ic bergs shimmered on the horizo Around us, the Arctic tundra glowe golden in the sunlight of late afte noon. At the edge of several sma marsh ponds, fresh grizzly track showed in the mud. And dead ahea the unreal twin radar towers o DEW-line drew our sight and step toward them. Fifty miles behind us the Brooks Range front threw a soli wall of snow-covered summits int the southern skies. Had we reall walked over them and across the intervening distance? The view dazzle us, and a floating sensation bega to take possession of my powers o awareness—a feeling that grew, a Barter's incredible pile of space ag and war technology closed aroun us, as if to insulate us not onl against some obscure threat fro Siberia but also from the more rea threat to civilization implicit in the vastness of this surrounding wilderness.

After crossing the channel to Barter Island with the aid of an Eskimo boatman, we finally found the military commander and a civilian aide. "Walked over the Brooks Range? . . . over the high peak region? . . . fo God's sake—why?"

tic marsh

SUPE



Female Hystricopsylla,
magnified twenty times.

BY VICTOR B. SCHEFFER

LEA

MEETS MOUNTAIN BEAVER

My father, Theophilus Scheffer, ho died at age 99, was fond of say-ıg that he would be remembered ngest for discovering the greatest ea in the world. In 1913 he had been ent by the Bureau of Biological Sur-ey to Washington state to study the abits of birds and mammals injuri-us to agriculture there. He retired 1937 and died in 1966, having ved longer on his Civil Service pen-ion than on his salary.

In exploring a nest of the large urrowing rodent *Aplodontia rufa*—r "mountain beaver"—he collected flea. It later became the type speci-nen of *Hystricopsylla schefferi* Cha-in, 1919.

In his 1947 book on fleas of west-rn North America, C. Andresen ubbard called it the largest known lea in the world, for he measured a pecimen 8 mm. long. He collected nly 29 specimens from 100 moun-ain beavers, which led him to con-lude that the flea must be rare, or is erhaps a "nest flea." George P. Hol-and wrote in 1957 that he had seen emale specimens more than 9 mm. (three-eighths of an inch) long!

Accidental hosts of the Scheffer flea are the spotted skunk and the mink, both of them predators upon the mountain beaver. Near my home I have caught spotted skunks in live traps set in mountain beaver runs, implying that the skunks follow the runs looking for prey. While invading the nests of the little *Aplodontia*, the predators presumably become infested with its fleas.

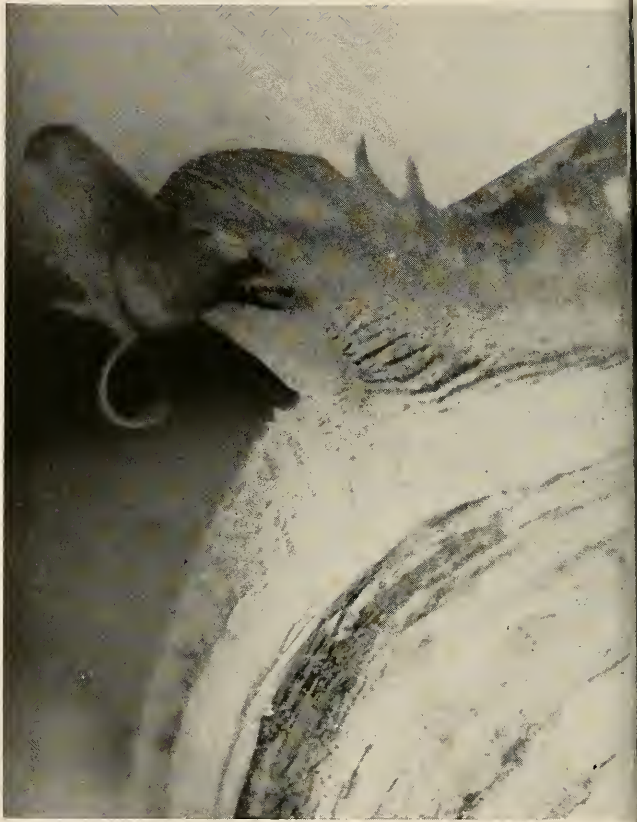
I am tempted to look for some obscure relationship between the large size of the flea and the ancient lineage of its host, but I find no clues. The mountain beaver is a "living fossil," the only survivor of the oldest known group of living rodents—the superfamily Aplodontoidea, late Paleocene to Recent. The only living species is confined to moist forests of southwestern British Columbia and the adjacent western United States.

Not only is the mountain beaver host to the largest flea in the world, but it is host to *no lice at all* (or at least, none have been discovered). This, too, is curious.

Mussels on the Move

Successful propagation by the mollusk at right depends on the appendage atop it, which serves as a minnowlike lure. Apparently flashing, it can attract a larger fish that will receive, nourish, and transport larvae discharged by the mussel

by John H. Welsh



A fisherman wades along a sandbar in one of the few remaining, unspoiled upper tributaries of the Mississippi River. It is a late spring morning and the sun has risen only a short distance above the horizon. There is no wind to ruffle the surface of the water. As he looks down to gauge the water's depth he sees a small, flashing white spot that has been made conspicuous by the dark background of the sandy bottom. Closer examination shows that the rapidly repeating spot is being produced by a large mussel partially buried in the sand. Curiosity leads him to collect the mussel and take it home. There he places it in a glass jar with sand and water and keeps a close watch.

After a few hours the mussel has relaxed and extended its siphons. Now, near the siphons, a fishlike object can be seen. At one end are eyelike spots; at the other, a fishlike tail. These, plus a characteristic pattern of pigmentation, give the appearance of a small minnow. Suddenly the tail jerks slightly, then again, and soon these movements reach part way toward the head in rhythmical, undulating waves. While this is happening the fishlike object is seen to separate into right and left halves; and as the waves approach the head, the halves spread to reveal unpigmented, white surfaces. The undulations now follow one another in rapid sequence—one to two per second. Viewed from above, the flashing spots of white appear as they did in the river. From the side, our fisherman has the impression that he is watching a small fish, such as a darter, struggling unsuccessfully to make progress upstream against a swiftly moving current.

Without fully appreciating its significance, our fisherman has observed a phenomenon peculiar to a group of freshwater mussels (often referred to as clams) that are found only on the North American continent. This group constitutes the subfamily Lampsilinae, of the family Unionidae. Through the ages, evolution has given most species of unionids an unusual method of propagating and providing for the distribution of their young. The method may vary but the problem is the same. Since many unionid species live in rivers and streams and can move around only with some difficulty, their young must be transported upstream somehow; other-

ise the population would suffer the ate of being gradually displaced rom the stream environment by the eaward current.

To begin with, the female mussel eleases eggs that her ciliary currents arry from the ovaries into certain ater tubes of the gill. It is in these visacs that the eggs are fertilized y sperm released by neighboring ales. Early development takes place ithin the ovisacs until a characterstic two-shelled larva, the glochidum, is formed. Eventually the glohidia are set free, but if they are to urvive, they must quickly attach to fish.

In some species of mussels this ransfer, though a critical event, is argely a matter of chance. Tens and ven hundreds of thousands of glohidia may be produced by a single female mussel in one season, but few survive to become adults. With these species the released glochidia drop to the bottom of the stream and lie with their shells gaping open. If a fish happens to swim near enough for its fins to touch the sensory hairs of a glochidium, the two shells are rapidly closed by a single muscle. With the edges of its shells grasping a bit of fish skin, and aided by two hooks, the glochidium can cling almost anywhere on the surface of the host fish. But the section along the edge of a fin is a favored place for attachment, and in this fashion dozens of glochidia may attach to the fins of the same host fish. Where a larva attaches itself, its shells pinch, and its hooks pierce, the skin. Epidermal cells of the host respond to the mild injury by growing over the larva to form a cyst.

The attached glochidia absorb nutrients from the host fish and over a period of a few weeks are transformed into miniature mussels. These are then released by a rupture of the cyst wall and drop to the bottom where, if conditions are favorable, they develop into adults. If the host fish has meanwhile moved upstream from the point where it was parasitized, the young mussels have been transported upstream a corresponding distance.

The Lampsilinae differ in several respects from the other unionids just described. Perhaps most important is the absence of hooks on the shells of the glochidia. Lacking hooks, they are less able to cling securely to the fins of a host fish while they wait for the cyst to form. But what if they were to be taken into the mouth of the fish by respiratory currents or by being eaten? There, a number of them would come in contact with the many gill filaments and their multitude of thin lamellae, which provide ideal places where the larvae—by clamping their shells shut—can attach themselves and proceed to secure nutrients from the rich supply of blood vessels. That is what happens. It is by means of this adaptive factor that the glochidia become attached to the fish without help from hooks. Cysts then form around them. After metamorphosis into miniature mussels they break out of the cysts, are expelled from the gill chambers, and drop to the stream bottom, where they develop into adults.

But how can the parent mussel insure that a fish will be near at hand when the glochidia are released? Some suitable way of attracting the fish would help, and using such a lure appears to be a second characteristic that distinguishes adult female lampsilids from the other unionids. A fishlike structure, appearing to struggle like an injured minnow, and producing a flashing white spot against a dark surrounding, should attract potential host fish. Several species of lampsilids are known to possess such lures. They are present only in the females and are well developed and active only when the female is gravid and ready to discharge glochidia. Our fisherman had observed such a female mussel.

But now there is another problem in this series of problems. What mechanism alerts the gravid mussel to the presence of a hungry fish and causes the release of a mass of glochidia? The signal might be tactile—that is, the fish might contact some touch-sensitive part of the mussel. It could conceivably be chemical—the mussel might "smell" the fish. The most effective signal, however, is undoubtedly the sudden reduction in light intensity produced by the shadow of a fish. Many bivalve mollusks are known to be unusually sensitive to a sudden decrease in light intensity. This "shadow response" usually results in the sudden closure of the shells, accompanied by the forcible expulsion of water through both the incurrent and excurrent siphons and between the mantle edges.

I have kept female *Lampsilis ventricosa*—the "pocket book mussel"—under observation in aquariums for extended periods of time. These, like all other lampsilids, carry their glochidia over winter and release them in the late spring and early summer. Only during the period of release are the fishlike extensions of the mantle edges well developed, extended, and likely to exhibit their characteristic movements. Under conditions of natural illumination these movements are most often seen in early morning and late afternoon periods when many fish are most active and feeding. The female mussel's brood pouches, or marsupia, occupy only the posterior third or so of the outer pair of gills. This is another diagnostic feature of all Lampsilinae. In gravid females the marsupia are distended by the masses of glochidia, and the rounded, pigmented edges of the gills often protrude between the mantle flaps that form the fishlike structures.

When watching *Lampsilis ventricosa* while the flaps were moving rhythmically, I have suddenly shaded the animals by passing a hand or object between window and aquarium. This usually results in some interruption of the regular rhythm of the flaps and some withdrawal of the siphons; but occasionally there is a rapid contraction of their muscles, the gaping shells close suddenly, water is expelled through both siphons and between the mantle flaps. At times this rapid stream of water has carried with it a glistening white mass of glochidia to a distance of several centimeters in the water above the mussel. These masses are about two centimeters long, a half centimeter wide near the middle, and one millimeter thick. Examination with a microscope reveals thousands of minute, hookless glochidia loosely held together by a binding material. In an aquarium, these masses, or conglutinates, drop to the bottom and, though they hold their shape for days, the glochidia soon die.

In nature, if a fish had produced the shadow resulting in the sudden release of the glochidia, it is highly probable that the mass would be seized by the fish. While most of the glochidia might be swallowed, some would attach to the gills. Nowhere in the literature have I found an account of such an observation. However, in 1912 two government researchers (C. B. Wilson and H. W. Clark) reported watching a dense bed of *Lampsilis ventricosa* in the Kankakee River. They wrote:

"The mussels were thickly scattered everywhere, with especially dense beds along the shore. . . . *L. ventricosus* has a habit of moving its bright-yellow siphon fringes, which are much enlarged during spawning, back and forth in the water. This undulatory motion seems to attract the small darters and minnows, particularly *Notropis blennius*, which could be seen darting in toward the fringes repeatedly.

"At intervals during the undulations small numbers of glochidia are discharged from the brood chambers of the mussel and carried out of the excurrent aperture. These glochidia are of the hookless type, and must be taken into the mouth of the fish that is to carry them during the parasitic period. We can thus understand the advantage of attracting these fish and keeping them in the immediate vicinity during the discharge of glochidia."

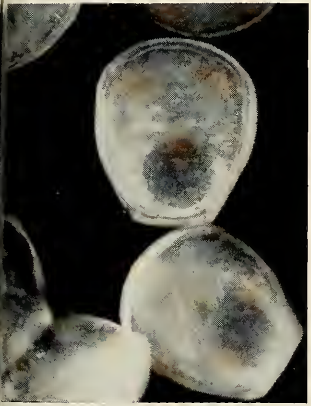
While we may question the use of the word "spawning" to describe the release of larvae, and doubt that Wilson and Clark were observing the usual glochidial release from this species, they were perhaps the first to recognize the adaptive significance of the moving mantle flaps.

To be sure, other functions for these remarkable, pulsating, fishlike structures have been suggested: aeration of the glochidia and propulsion of the glochidial masses from the mussel. But it is difficult to conceive that *Lampsilis ventricosa* would have evolved a structure so closely resembling a small fish unless its primary function was to lure fish into becoming hosts for their glochidia. One can only wonder how such structures came into being. They are present only in females of certain species of the genus *Lampsilis*. In addition to *L. ventricosa*, well-developed and fishlike lures occur in *L. fasciola*, *L. cariosa*, and *L. siliquoidea*. In *L. radiata*, of the Atlantic slope, there are only fishlike tails extending from the midventral region of the mantle edge. These move spasmodically in gravid females but such movements might attract the attention of hungry fish.

Females of *Ligumia nasuta*, also found in the eastern states, have no outgrowths of the mantle edge, but in gravid individuals thin, ribbonlike membranes close the gap between the partially open shells. The outer surface of these membranes is darkly pigmented. In relatively low light intensities, as in early morning or late afternoon, I have observed a peculiar movement of these membranes. About midway, the opposing edges separate for a distance of several millimeters. This reveals the white surface of the visceral mass. Suddenly the white spot appears to move rapidly toward the siphons. This results from a wavelike movement of the opposed mantle edges. When the waves, hence the white spot, reach the incurrent siphon (a distance of about three centimeters) they stop and immediately begin again in the midregion. The waves repeat at a frequency of about one cycle in two seconds, at a temperature of 21°C. and a light intensity of 50 footcandles. The regularity of the rhythm is remarkably constant. To a human observer, and perhaps to a fish, the eye-catching feature here is the white spot that appears to move against the dark background of the mussel and the substrate in which it is half buried. Certainly this could be a lure to host fish and may represent a specialized adaptation from

Larval mass, above, has individua right, ready to clamp th shells shut. Larvae emerge fr paired brood pouches atop muss which the more elaborate, fishlike lures evolved.

For some genera of the Lampsilinae little is known about possible means of attracting host fish to carry their glochidia. However, one unusual adaptation has been reported in a species of *Cyprogenia*—a genus in which the ovisacs of each marsupium are elongated and curve back toward the base of the gill, giving the marsupium a semicircular configuration. In the early 1930's, T. K. Chamberlain was keeping specimens of *C. aberti* in laboratory tanks at the U.S. Bureau of Fisheries laboratories at the University of Missouri. One day he happened to observe a bright red, wormlike object extending from the excurrent siphon of one of the mussels and waving in the current of water expelled from the siphon. Removing the object, he found it was about three centimeters in length and comprised many glochidia held together by a binding substance. He noted the close resemblance of these strings to tubificid worms. Further study showed this to be the normal manner in which the glochidia of this species are discharged. Suspecting that this might be a means of attracting fish, he placed goldfish in aquariums with gravid *Cyprogenia*. He wrote: "In every case the fish greedily ate any exposed conglutinates [the wormlike strings]. The fish quickly seized incompletely extruded conglutinates and pulled them out of the exhalant [excurrent] siphon of the gravid mussel. . . ." The goldfish that had fed on the wormlike masses were afterward examined. In every individual, glochidia were found attached to the gills. He concluded that the wormlike conglutinates may serve to lure host fish.



Most animals that have a parasitic phase during the life cycle either actively seek the proper host (for example, parasitic wasps), or have active larvae that search for, and identify, the host (for example, flukes). I can think of no group of animals other than the lampsilid mussels that have a potential means of attracting hosts to their vicinity, thereby enabling their larvae to enter or attach to the host species. Yet this unique phenomenon is known to few biologists, including many who specialize in mollusks. This is due, in part, to the restricted distribution of the Lampsilinae. If they were to be found in other parts of the world, and especially in Europe, this curious adaptation might be better known.

The discovery of these fishlike structures is not recent. Isaac Lea, a prominent early American naturalist who spent a lifetime describing the freshwater mussels of this country, published, in 1838, a good figure of the fishlike mantle flaps of a lampsilid mussel. In the early part of this century, when the protection and propagation of the mussels of the Mississippi Basin—for the then-flourishing button industry—became the concern of the U.S. Bureau of Fisheries, several investigators rediscovered these fishlike structures in various species of the genus *Lampsilis*. Since then, little attention has been paid them. Currently, there appears to be only one person. Dr. Louise R. Kraemer of the University of Arkansas, who is actively investigating the comparative morphology, behavior, and functional significance of the fishlike mantle flaps of certain lampsilids. It is urgent that such studies as these of Dr. Kraemer be encouraged, since the once-abundant supply of lampsilids is rapidly vanishing. A century ago, freshwater mussels were more abundant and varied in the upper Mississippi drainage than anywhere else in the world. Then pearl fishing began depleting them, as did the button industry, which obtained from mussels the hard, pearly internal layer called mother-of-pearl. Drainage, damming, silting, and pollution have also contributed to the destruction of most of the mussel beds. Unless there is protection of the few remaining rivers and streams in which they are still found, this extraordinary example of adaptive evolution will be lost forever.

SKY REPORTER

YEAR OF THE PLANETS While world attention focuses on the drama of men landing on the moon, the Soviet Union and the United States continue to explore nearby planets with space probes. This month two Soviet capsules will attempt soft landings on Venus; two American spacecraft will swing by Mars later this summer.

The Russians have had mixed results from their Venus probes. The first two missed; the third hit the planet without sending back any data. Venus 4 made a successful landing in October, 1967, but the data it returned was compromised by scientific arguments over how high above the surface the capsule was when it stopped transmitting.

Presumably the Russians hope to settle any arguments by using two capsules this time. Both are to land in areas of Venus facing earth, and the plan is to have them transmit data as they descend slowly to the surface. Although the Russians did not mention the possibility, they are expected to try to keep the capsules transmitting even after they come to rest on the surface.

The American mission to Mars is a more modest effort. This year's Mariners will fly by Mars at a distance of 2,000 miles, transmitting television pictures and instrument readings of its atmosphere and surface.

Two years from now, two more Mariners will cross space to orbit Mars for three months. Only in 1973 will the U.S. launch Project Viking, an attempt to soft land instruments on the planet's surface. Final decisions for each mission will be made only when the results of the previous mission are in.

(By mid-March the Russians had not taken advantage of the launch window then open to Mars. They had not missed such a window for nearly a decade, however, and were expected in some quarters to try a soft landing on Mars at about the same time U.S. astronauts might be trying a soft landing on the moon.)

INTERSTELLAR WATER Two months ago this column predicted that water might soon be found between the stars. Almost immediately, the same team at the University of California at Berkeley that first reported the discovery of interstellar ammonia announced the detection of water molecules.

Using the same 20-foot radio telescope at Hat Creek, California, Charles H. Townes and four other scientists have detected water molecules in at least three different regions of the Galaxy: a radio source in Sagittarius where ammonia already has been detected, the Orion Nebula, and a radio source in the Milky Way in Aquila.

The Berkeley team used a method first suggested by Townes in 1955. Interest in a program of interstellar water detection had been expressed as recently as the December meeting of the American Astronomical Society in Texas. Presumably a catalog of interstellar water radio sources will now rapidly take shape.

We said in March that water and methane were likely candidates to be found next in the dust clouds at the center of our Galaxy. Now we'll wait for a report on methane, the simplest hydrocarbon, known in some circles as marsh gas or as a component of natural gas.

MEDAL FOR AMATEURS This month sees reactivation by the Astronomical Society of the Pacific of an annual award to a nonprofessional for contributions to the study of comets. The award will be made for the first time in 15 years.

In 1890 the society received $500 to subsidize purchase of a bronze medal each year for comet discoveries: it was called the Joseph A. Donahoe Award. By 1955, however, the cost of a bronze medal far exceeded the interest received from investment of the gift, even with capital gains.

Last year the society voted to reactivate the award, changing its name to the Astronomical Society of the Pacific Comet Award; more importantly, it will be given for all past contributions to the study of comets, and not for the discovery of a single comet.

Half of all new comets are still discovered by amateurs; their only reward is the limited immortality granted by their name being given to the comet. The ASP medal will afford slightly more public recognition.

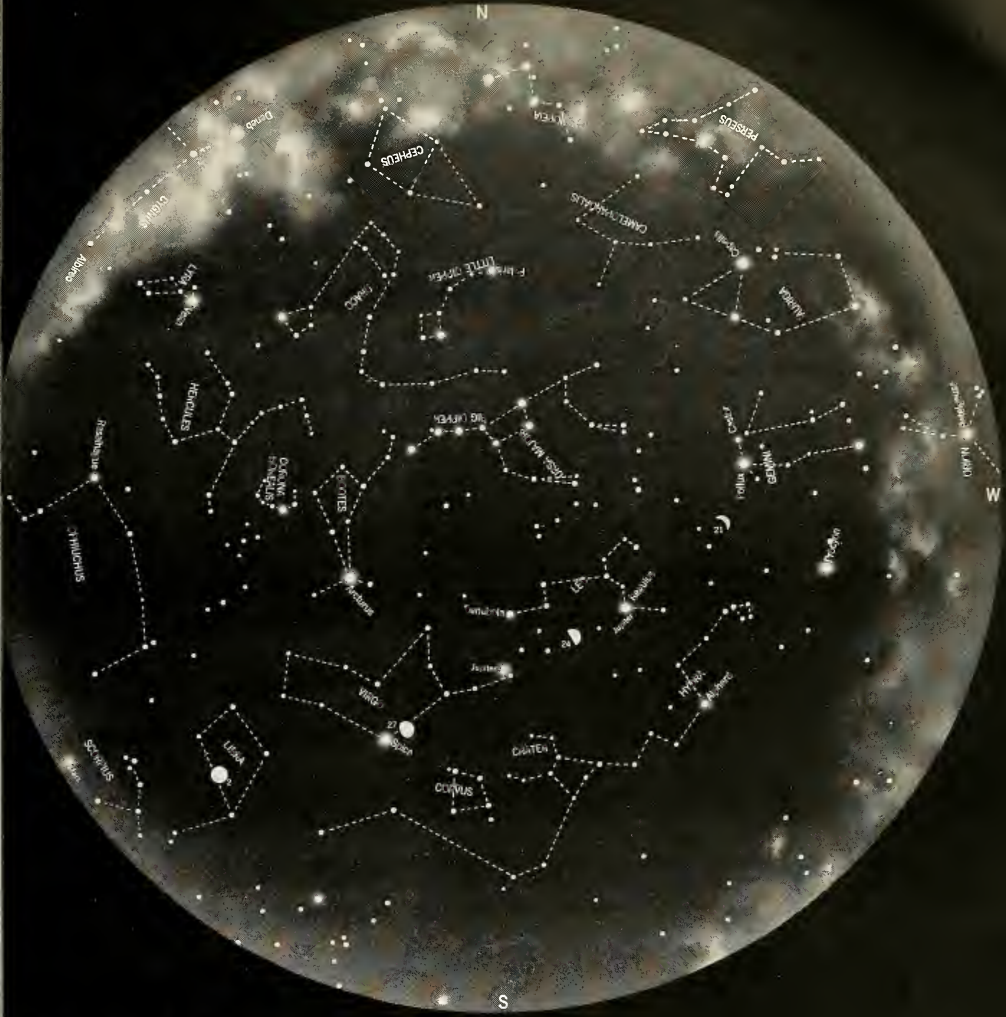
ON THE RAILROAD TRACK British Rails' loss has been Cambridge University's gain. Sir Martin Ryle has been given the highball signal to build a three-mile radio telescope array along a section of abandoned railroad right-of-way adjoining the existing Mullard Radio Astronomy Observatory. Gleaming computers will line a control room where the boarded-up Lord's Bridge station now stands.

The British Science Research Council has approved $5 million for the array of eight 42-foot radio telescopes. Four of them will be movable along the right-of-way. They won't use the existing track, however; they'll travel on special tracks 25 feet apart and accurate to one millimeter in three-quarters of a mile.

The array will perform what is known as aperture synthesis. This means that, as viewed from a radio source in space, rotation of the earth will cause one dish to describe an arc about another. If one of the dishes is moved the next time, it will fill in another arc. If enough swings are made, the rig will have an effective aperture equal to the maximum distance between dishes. In the Cambridge case, the 42-foot telescopes will give the same results as one telescope three miles across. Four of the dishes are movable, so only a quarter of the number of swings to fill in the aperture need be made.

The British journal *Nature* reports Professor Ryle will use the new telescope, to be ready in three years, for mapping. Using the equivalent of a three-mile telescope will enable Cambridge astronomers to plot the positions of radio sources far more accurately than had been possible and to detect fine structure within extended sources. The existing one-mile array will be retired to source counting.

John P. Wiley, Jr.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CELESTIAL EVENTS

Full moon occurs on May 2, last-quarter on May 8, new moon on May 16, and first-quarter on May 24. The moon will be full again on May 31.

Mars and Jupiter are in the evening sky all month. Mars, rising shortly after sunset, remains visible till dawn. Jupiter, high in the south at sunset, sets after midnight. Venus becomes a prominent morning star, and Saturn may be seen in the morning sky toward the end of the month.

May 3-4: The moon is near Mars and the star Antares. Mars is to the left of the moon in the evening sky of the 3rd, and Antares is to the right, near the moon. On the evening of the 4th, Mars is to the right of the moon, Antares still farther to the right.

May 5: Mercury is at greatest elongation in the evening sky and appears low in the west in the evening twilight. This is a favorable elongation, since the planet is nineteen degrees high at sunset.

May 12-13: Venus is below the crescent moon in the morning sky of the 12th and above the moon on the 13th.

May 14: Venus, rising about two hours before sunrise, reaches greatest brilliancy in the morning sky.

May 18: Mercury is stationary and begins to move retrograde.

May 23: Jupiter becomes stationary and now begins to move eastward through the stars of Virgo.

May 25-26: Jupiter is to the east (left) of the moon in the evening sky of the 25th, to the right (west) of the moon on the 26th.

May 29: Mercury is at inferior conjunction and becomes a morning star.

THOMAS D. NICHOLSON

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 9:25 P.M. on May 1; 8:30 P.M. on the 15th; and 7:25 P.M on the 31st; but it may be used for about an hour before and after those times.

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A Golden Eagle and the Reari

by Frances Hamerstrom

As a child I watched an eagle soaring above the mountains and yearned to share its existence. It wasn't a dream likely to come true, but now I am a professional biologist, and twice I have had the rare experience of helping a golden eagle build her nest. In a way, she accepted me as her mate.

My eagle's name is Chrys, from the Greek word for "gold," and she means more to me than the riches of the Indies. That Chrys has the notion I am her mate is not really odd. She was hand-reared by a friend of mine, so, at an impressionable age, she accepted people as eagles. She was taken from under the nest, or eyrie, when she was about eight weeks old. Now, at the age of six. she weighs ten pounds in hunting condition and thirteen pounds when fat and lazy.

The preliminaries for nest building start in February each year, when Chrys begins to show an interest in sticks, preferring those about two feet long and not more than one inch in diameter. Stick-play seems to be an important part of prenuptial communication and stimulation between golden eagles. I toss her sticks, which she catches or pounces on; then she carries them about in an apparently enthusiastic, yet aimless, manner.

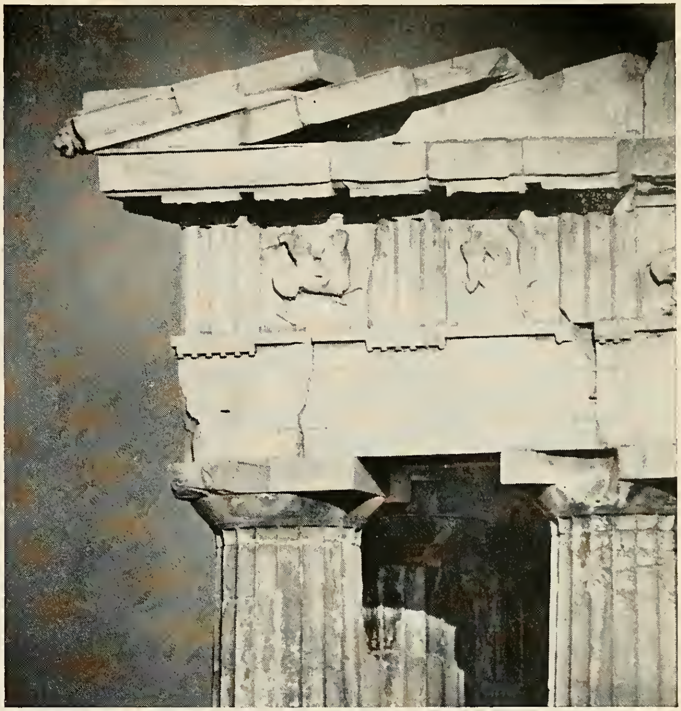
She also starts to sing in February —a curious, melodious song, somewhat reminiscent of the call of a wild turkey but more musical and varied. On moonlit nights, I often hear her singing as long as I am awake. During the daytime she is most likely to sing when she hears or sees me, but occasionally she sings when other people appear. This suggests that she was taken from the eyrie late enough in her development so that she is not firmly imprinted on any specific person.

I believe Chrys might accept a male golden eagle. But penned, captive animals do not behave as animals in the wild do, and Chrys is so powerful that I fear she might kill

Redtails

male. Males are smaller and gentler an the considerably more formid- le females. Artificial insemination a possibility, but I don't know how where to obtain golden eagle men. In this quandary, the best I n do now is to take my cues from hrys. Let her nest if she will: I can ly watch and learn.

On April 10, 1966, Chrys started build a nest on the ground beside er block perch, and began pulling athers from her breast. She was stened to the perch by a strong ylon leash, attached with a swivel to ather jesses on both her legs. Frank enn, a naturalist visiting us, and I ecided that we must move her perch a summer position where she could et some protection from the heat of e summer sun four months hence. loving the perch was not an easy ndertaking, for its base was buried eep in the frozen ground. First I rried Chrys to a 27-pound tempo- ary perch and tried to feed her, but e would not eat.



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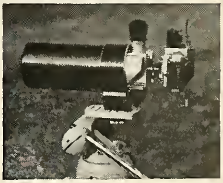

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Digging up her old perch was cold work, and after awhile we went into the house to get warm. When we returned, to our amazement, Chrys had dragged the temporary perch all the way back to her rudimentary nest!

Since one dare not leave a leashed bird unattended with sticks nearby, as it could get entangled—even hung by the feet till it died—I tossed the sticks out of her reach. By 11:30 P.M. Chrys laid the first egg of her life and began incubating it without a nest—flat on the ground. Three days later, she broke the egg, which mysteriously was yolkless, and I gave her a chicken egg, which she accepted. On April 15, she laid a second egg. She was four years old when she started to lay.

The winds howled out of the northwest, but hour after hour, day and night, Chrys lay flattened on the ground, incubating and hardly ever feeding. We watched her helplessly from the house. How could I have been so stupid as not to realize that it was up to me to take my turn at the "nest," which now consisted merely of a little hay that I had previously given her.

On April 20, she broke her second egg, not yolkless this time. But, she still incubated the chicken egg.

Sleet is worse than cold or snow. After fifteen days of incubation, during which Chrys left the egg only for short preening and feeding periods, she deserted it in a sleet storm on April 26. But not without a struggle. Although the egg was stone cold and the hay was wet and slightly frozen, she made several attempts to sit on the egg and tried to draw dry hay around it, but finally gave up after about half an hour.

The entry in my notebook is terse. "Lesson: In bad weather, during preen period, keep her egg warm and her nest dry."

In summer she was placid; she lived a lazy life—molting, feeding, and often sunning herself. The first time I saw my eagle sun herself, I ran to her in fear, for the great bird, lying on the grass with wings outspread, looked dead to me. Indolently she moved her head, and as soon as I recovered from my concern, I lay down beside her to sun myself too, and basking like a lizard, fell asleep.

I know little of the temperament of wild eagles, but trained eagles undergo a profound personality change when cold weather sets in. They l some of their summer fat, and if o does not cut down on their ratio they are apt to go on hunger stri for several days. Their reflexes b come quicker, they are harder handle, and they are eager to fly.

Day after day I flew Chry whistling her in to my glove wh I wanted her back. One day I h been watching her glorying in t wind, high over the meadows, wi the dark winter storm clouds as h background. That evening a visit said, "I hear you have a capti eagle." Captive? In a way I suppo a dog or a horse or one's own ch dren are captive: one influences the and had better do so. Such is my a titude toward motherhood or livi with an eagle. I spend an enormo amount of time with my eagle ar there are those who would inquir "Which is the captive?" Suffice it say, the bond is strong.

One day in December I cast Chry off, to use the falconer's expressio The night before had been windy an cold, and we were both excited. stood in an icy meadow, expectin her to fly three hundred yards, or pe haps a quarter of a mile, no tellin how far. She spun at eighteen inche instead. Awkwardly, with poor foo ing, I threw up my arm to protect m face. Wings outspread, with the win behind her, she hit the glove, and th force of the blow pulled the tendon in my arm. For the rest of the winte I was unable to carry an eagle—no could I even raise my hand hig enough to comb my hair. Pulled ten dons mend slower than broken bones

Our household was well aware tha April 10, the anniversary of Chry first egg laying was being awaite with anticipation in 1967. This time we would build her a good rearin pen, well sheltered from sleet storms All were astounded when on March 24, seventeen days before we expected anything to happen, I came rushing up to the house shouting "Chrys's time is near! Help me! Three of us partitioned off part o our machine shed, and my excitemen was so great, I ran to the shed wit a heavy eyrie base that I ordinaril would not have dreamed of tryin to carry.

Chrys took to the platform righ away, and I presented her with sticks As though possessed, she built th nest, laying the sticks crisscross an

Overseas
Nature Tours

or eight years we have been organizing group s to investigate the natural history of Europe, ica and the world. See summary of world gram in opposite column. Below are details groups now forming:

— SOUTH AMERICA —

Feature for the Fall of 1969 is a series of 3-ek tours circling South America, starting Aug. in Colombia and swinging counter-clockwise und the continent. We'll go as far south as rra del Fuego, touch all the famous bird ob-vation highlights of the Andes and both coasts, d end in Venezuela before Xmas. See dates in posite column, and let us send you the itinera-s.

— EUROPE —

r extraordinary 1969 coverage of Europe in ven separate tours is by far the broadest view this continent's natural history and off-route enery ever offered. Take single excursion trips r economy, or combine tours to produce the ute of your own choice. Our "Europe 1969" der shows you how. All under top ornithological d botanical leadership, of course. Each tour, 3 eks.

ROPE SOUTH covers France's Camargue and Riviera, Switzerland's birds and alpine flora, famed Neusiedlersee on the Hungary border, and the Rhine country; May 8. **EUROPE NORTH** takes in northern Germany and covers Sweden fully to and beyond the Arctic Circle; May 29. **NORWAY**, our most popular of all, covers fjords, mountains and coastal islands in an itinerary that has become famous; June 22. These 3 tours combine into a memorable journey "north with the spring" from the Mediterranean to North Cape and the Arctic.

EDITERRANEAN begins at Lisbon, visits Spain's famed Coto Doñana, France's Camargue, Corsica and northern Italy; May 8. **BALKANS** starts at Venice, visiting bird and botanical highlights of Yugoslavia, Greece, Turkey, Romania and Hungary; May 29. **U.S.S.R.** starts from Prague June 22, covers natural history highlights of Poland and Russia. **SIBERIA** is a 3-wk. link in an economical round-the-world route; the Asian U.S.S.R. republics, Lake Baikal and a journey into Outer Mongolia are features; July 13. These 4 tours combine into an extraordinary nature experience.

RITAIN, leaving May 29, is a popular broad coverage from southeast coast to north tip of Scotland. **ICELAND**, 2-week visit to this weird country, offers a choice of departures (June 28 or July 21), with a new 10-day camping trip across little-visited centre and east coast areas available between the tours, and a visit to Greenland optional at the end.

COMING IN 1970: A thrilling series in Asia starts in January with **HIMALAYAS, INDIA-CEYLON, THAILAND-CAMBODIA** and **MALAYSIA**—four connecting 3-week trips. A remarkable coverage of South Asian birds and wildflowers, combining into a memorable round-the-world experience stretching between Christmas and Easter.

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settling each one into position. The egg was coming, and there was no time to be lost. The rim of the nest grew higher and higher; then, as though a signal had been given, she started refusing all but the smaller sticks. I was learning to learn from an eagle. I offered her little sticks and then hay—which she accepted voraciously. We worked on the nest an hour or two a day, which seemed to satisfy her. On March 28, her concentration was centered, for the most part, between her feet: she pulled hay from between them toward the outside of the nest, and then, reaching as far as she could, she pulled hay from the outside toward the center. Her motions were in no way reminiscent of the crisscross laying of the branches that had formed the bulk of the nest's foundation. She was now digging a cup, calling frequently and working with high intensity. Occasionally, she plopped down on her breast. When she stood, her undertail coverts often pointed downward.

From time to time she preened her breast feathers and gaped with her head held high. I stood beside her, often stroking her neck. Next she pulled material from between her feet only. She gave several chick-like cheeps, punctuated by soft, deep grunts. Each time she thumped down on the nest she struck it with the upper part of her breast, almost at the wishbone area, and each time she gave her tail two or three little sidewise flicks before getting up.

By about six in the evening, she started rocking from side to side, as if bathing, and at 6:08 when she next got up the egg was there.

On April 2 there was long continuous singing. Chrys had a second egg. She had ripped apart a paper bag and added it to the nest. As far as I know she had never brought material to the nest before. I was shocked to find that she had left the nest unattended in such cold weather, and I was becoming perturbed at her refusal to eat. I ran to the house to get our son's blue hot-water bottle and rushed back to the nest. When I stayed at the nest for a while, Chrys reacted as though I had finally come to my senses. She stepped off the nest, I put the hot-water bottle on the eggs, and Chrys pounced on a dead chicken and ate it. The chicken had lain near the nest, in sight and untouched, for days.

Overseas
Nature Tours

— 1969 Program —

Here is a summary of our 1969 program. Space permits only brief mention of each tour, and one should, by all means, have the "Tour Catalog" with thumb-nail sketches of each trip. Early registration will save disappointment, and may be made tentatively. North America tours 2 wks., remainder of the world 3 weeks each, except as otherwise noted.

— NORTH AMERICA —

TEXAS BIRDS: Whooping cranes, Rio Grande reserves, Northeast Mexico. March 15.
TEXAS WILDFLOWERS: Separate wildflower group on above route. March 15.
ARIZONA: Popular bird tour of southeast Arizona under Dr. Robert Ohmart of University of Arizona. April 26.
CASCADES: North through Oregon and Washington reserves and parks. May 31 (3 weeks.)
ALASKA: Three successive 2-wk. trips: (1) The inside passage and Yukon; (2) the central region with McKinley Park, Kenai, Kodiak and Katmai; and (3) outposts of the Aleutians, Pribilofs, Nome, St. Lawrence . . . Island, Kotzebue and Point Barrow. Series begins at Seattle June 21.

— MIDDLE AMERICA —

PANAMA: Bird concentrations of Canal Zone & Panama mountains. March 1-15.
Yucatan, Panama and Colombia are done twice a year in a continuous chain, affording a 7-week view of the bird and plant life of tropical America that is both memorable and economical. In 1969 this series starts Jan. 11 and July 19.

— SOUTH AMERICA —

COLOMBIA: World's top bird country. Two 1989 departures: March 15; Aug. 16.
ECUADOR-PERU: Heavy bird populations of jungles & high Andes, including Machu Picchu and upper Amazon. Sept. 6.
CHILE-ARGENTINA: Highlights of both coasts, plus Tierra del Fuego. Sept. 27.
BRAZIL: Iguasu Falls, the Rio coast, central jungles and the Amazon. Oct. 18.
GUIANAS-VENEZUELA: The 3 Guianas, Trinidad and highlights of Venezuela. Nov. 8.
The 5 South America tours, starting with Colombia on Aug. 16, readily combine into a remarkable grand tour of the continent.

— EUROPE —

By all means obtain the detailed announcement of our 11-tour 1969 Europe program, with its many possible combinations. See opposite column for additional information.

— AFRICA, ASIA, ETC. —

SOUTH AFRICA: This popular trip includes S.W. Africa and the Kalahari.
EAST AFRICA: Extremely heavy bird concentrations, many big mammals.
CENT. AFRICA-MADAGASCAR: New and promising, beginning at Victoria Falls
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Day after day, I took my turn at the nest. Each morning at about ten o'clock, I heated the water, put it into the bottle, and trekked through the snow to put it on the eggs. Ordinarily Chrys left the nest for about twenty minutes. Sometimes she wanted as much as forty minutes to feed, preen, and romp about.

It is not unlikely that she looked forward to having me take my turn at the nest more than I did. Her distress was so obvious when I tried to leave the bottle and go away that it was plain that my presence in the miserably cold shed, beside the eggs, was essential to her peace of mind.

Usually she returned to the nest of her own accord, waited until the bottle was removed, and then settled down to incubate. If it seemed that she was taking unduly long at her turn off the nest, all that was needed was for me to pick up the bottle and leave. She was not going to let those beautiful brown and white eggs get cold. Her eggs were infertile, of course.

I suspected it was important that in the future she have something to raise. My friends were alerted: we needed tiny red-tailed hawks for Chrys to adopt. On April 17. a friend arrived with a two-day-old redtail chick.

First I daubed an empty goose egg, originally blown for an Easter party, with watercolor to make it look like one of her own; then to make it look like a hatched egg I tapped it open carefully, as the British do in preparing to eat a soft-boiled egg. At 10:10, with assumed nonchalance, I went to take my turn at the nest, carrying the two-day-old redtail chick. Would Chrys eat it? Could I get it away from her if she tried to? I tossed Chrys some food, and she pounced on it. Then I stole one of her eggs and put it in my parka pocket; in its place I put the goose egg with the redtail chick inside. The chick peeped but I held the egg closed. At the sound of the chick, Chrys returned to the nest immediately without feeding. The chick struggled out of the egg and Chrys walked around the chick. Four times she lowered her great head and touched the chick's egg tooth with her beak. With her feet held sidewise, she pushed the chick, the eggshells, and her remaining egg together, pulled aside the torn paper bag, and settled down to brood, moving f
more slowly and carefully than usua
Then she gave her customary ta
switch. There was no thumping dow
onto the eggs this time, and her sid
wise rocking as she settled was as
in slow motion. She gave her usu
greeting call and a new sound–
soft "boop"—as she settled. Whe
incubating the eggs, she has alway
faced north, and it seemed odd t
see her on the nest facing in anothe
direction. When brooding, she si
higher in the nest and faces in an
direction. One wonders whether thi
is typical of golden eagles in the wil
or merely an idiosyncracy of hers.

The chick weighed 62 grams, a
most half the weight of the 126 gran
egg taken from Chrys. An eagle
would be far larger, and I wondere
how well the early feedings would go
Frank Renn fed the chick at the hous
to get it started, while I took my tur
at the nest (Chrys let me walk awa
with the chick peeping inside m
shirt). As soon as I brought the chic
back to her, she tried to feed it, tak
ing bits of food from my hand. Sh
took each morsel deep into her throa
first, until it looked as though sh
had swallowed it, but each time sh
worked it up again and offered it t
the chick, gently brushing its beak
and the sides of its head with th
food. Whenever the chick lay quietl
with head down, the eagle egg beside
it was taller, and Chrys tried to feed the egg. Chrys was stimulated to feed by the sound of peeps. She offered food to whatever was moving, and if nothing moved, she fed the highest object in the nest, whether the egg or my fingers. Quoting from my notebook, April 18, 1967, "It is 32 degrees and Frank and I fear that the size discrepancy between the redtail chick and a newly hatched eaglet is still too great for efficient feeding, but she must keep trying or she may never feed the chick properly."

Although I never thought Chrys had much feeling in her feet, once when she stepped on the chick's neck she arched her toe and did not hurt him. Another time, she started to step on him but repositioned her foot when he complained. Perhaps she had also heard his complaint call when she stepped on his neck. I decided to watch to see whether tactile response is enough, or whether the chick's complaint call makes her move her foot. (No auditory stimulus

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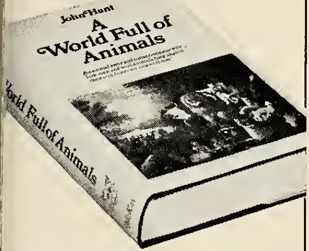

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is necessary to make her careful with her beak.)

"She can roll the egg and the chick together before settling down to brood—chick does not complain .... It is difficult to realize that these great feet, which pulled the tendon in my right arm in the winter when she was in yarak [good flying condition]—pulled them so that it hurt to lift a teacup and I was unable to lift her (about 10 pounds) for the whole winter—these feet, opening and closing the toes gently and so slowly, are to be trusted not to hurt a 62 gram chick."

On April 20, Chrys and I both tried to feed the chick. We offered it morsels of meat from our mouths, Chrys working the little chunks of pigeon up from somewhere deep in her throat, or even from her crop, and I doing the best I could by holding them in my mouth. We both concentrated on the task in hand, and somehow, I inadvertently got a morsel that she had regurgitated into my mouth. The wet, slippery coating tasted sweet-salty (actually very good). The taste was less salty than the "juice" which runs out of her nares when she is being fed. One wonders where this salt supply comes from. She had been in captivity for five years; to the best of my knowledge, no one had ever given her any salted food, but she still exuded salt —as wild raptors do.

There are advantages to having Chrys trying to feed the sides and back of the chick's head; it wakes him up. April 21: "The chick has a full gorge. Chrys must have fed it. Today, for the first time, she fed my fingers a small chunk of bone (which I rejected). She also brought a big stick to the nest while I was feeding the chick his supper."

April 22: "Frank fed the chick at 8:00, 2:00, and 7:00—not very hungry. Cold and snow today. Chrys ate part of a chicken; she has eaten very little since the hatch—a mechanism to keep her from eating the chick?"

April 23: "Chrys's pen is 15 by 21 feet and 11 feet high at the peak. She is in the pen, not because I fear to lose her, for there is little doubt in my mind that nothing would induce her to leave the nest for long. I can walk in and out of the pen, handle the chick, or even push her out of my way if I want to. But the other day, she prepared to attack two visitors,

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who beat a hasty retreat." Later a Weimaraner dog appeared. With both feet extended, Chrys made an instant attack, denting the sturdy welded wire between her and the dog.

There was a delight now in sharing the nest doings with Chrys. Taking my turn with the hot-water bottle on the eggs had become a cold, unpleasant chore after the novelty had worn off, but now, because of the chick, there was a comfortable busyness about the nest. Chrys fed the chick, then I did. Chrys fed my fingers. "I can influence her feeding: if, when she feeds my fingers, I pluck hard at her beak, she gives my fingers another and larger mouthful directly, but if my fingers accept the meat gently and daintily, she regurgitates a smaller piece for them."

We had been giving the chick vitamin supplements. By April 23, he was making more grown-up sounds, but his weight remained at about 77 grams.

April 24: "This morning I have varied the diet and go to the pen with venison in my pocket. Chrys looks different. She is facing north! She is 'brooding' low and hard and is reluctant to get up. Chrys is incubating again. The dead chick, with full crop, lies on the edge of the nest." An autopsy revealed Salmonella was the probable cause of death.

I was distressed—aware that I must have fed it infected food, and worried lest my careful preparations had been all in vain. Could another chick be found in time? Chrys was still incubating on April 30, when a friend helped me get a redtail chick. It was about a week old and fitted nicely into the goose egg. Quoting from my notes, "The chick peeped. Chrys really trumpeted. She flew back to the nest and walked around the chick. Once she put her foot on it and although it made no sound, she lifted her foot. The adoption was far quicker this time. She touched its beak with hers once, rolled the egg behind the chick, and settled down to brood, facing south."

The very next day, Ron Austing, the nature writer, arrived by plane from Cincinnati with a huge two and a half week old redtail. Although the new redtail still had his egg tooth, his primary tips already showed. It was plain to all that *he* was not going to fit into any goose egg. We would just have to put him on the nest

and hope for a successful adopti
Chrys had eaten nothing the d
before, confirming my suspicion th
the sound of a young chick puts
her appetite. I would far rather ha
introduced the big chick to her wh
she had just had a full meal! It w
not without trepidation that I we
to the eagle pen, with Big Chick
side my shirt to keep him warm.

Chrys's food still lay untouche
She stood up, and I quickly snatch
Little Chick from between her f
and stuffed him inside my shirt t
Chrys seemed ready to feed, but
shrill "cheep" from the vicinity
my midriff halted her.

To drown out the sounds of chee
ing, I sang. Rocking the chic
gently, shivering as the wind roar
through the pen, I sang lullabies
loudly as I could. Chrys footed t
meat once and then took her fi
bite. I cannot carry a tune, but I ke
up the volume. It takes a long tir
for an eagle to eat part of a rabbi
she took her time—I only rememb
two lullabies.

When Chrys had finally fed, B
Chick was adopted without misa
venture. If the members of the hous
hold heard the "singing" they we
kind enough not to bring it up.

Chrys fed both chicks in the afte
noon. She accepted Frank at the ne
now. He noticed that when Big Chi
had a string of intestine hanging o
of his mouth, Chrys took it awa
She made continuous "clucky
sounds and rubbed her wing again
Frank while he cut up a rabbit. Chr
was stimulated to feed the youn
whenever Frank or I went to the nes

Big Chick appeared to dislike th
sound of Little Chick's "peeps."
first he scurried away and almo
fell off the nest, but later he tende
to withdraw more slowly to await h
turn. Little Chick was fed first. Partl
grown Cooper hawks or harriers als
tend to scurry away upon hearing th
shrill cries of their smaller nestmate
It gives the littlest ones a goo
chance to survive.

By May 7, the chicks seemed bi
enough to have Chrys tear their foo
up for them. Having read that th
male eagle always plucks birds b
fore bringing them to the eyrie,
made it a point to pluck pigeon
chickens, etc., before taking them
the nest. It did not enter my head
pluck a rabbit, however! I laid
whole rabbit on the edge of the ne

nd went away. By my next visit hrys had almost entirely plucked it, lthough the head was left furry. It as curious to see a rabbit almost enirely without fur. The whole nest as strangely beautiful, seeming ightly afloat with gossamer. I was nchanted, and failed to recognize hat common sense was indicated. I hould have seen it was dangerous.

The next day Little Chick held is head up for food, but he had abbit hair in his eyes and could no onger see. Frank patiently removed air from Little Chick's eyes, while did what I should have done in the irst place: cleaned the nest. Little hick recovered in a day or two.

The young redtails soon started sing their sun porch. We had made hole in the wall, just back of the est, large enough so the redtails ould come and go as they pleased, ut too small for Chrys's big body. ig Chick was soon flying about, esting the wind, perching in tree ops; but whenever he was hungry e flew to the sun porch and scuttled hrough the hole to be fed by his oster mother.

At about this stage we took Big hick away for about two weeks, for raining, and little did we dream what ould happen when we returned him n the 23rd of June. He recognized is favorite perch trees. Then Chrys tarted calling! Perhaps he rememered her call and that food was to e had at the nest, which still conained Little Chick. Everything eemed to be going nicely for a short ime, but Little Chick had grown and hanged beyond recognition. Big hick had expected to find food, and ithout hesitation he grabbed his ormer nestmate with both feet, pullng him under the nest.

Chrys intervened, so Big Chick ooted her, an eagle, in the breast! rank, who had rushed to the rescue ithout a glove, pried Big Chick way. All three had talon marks. It as the end of an era. Big Chick ever again was allowed on the nest. t was not long before Little Chick as free flying, and soon it would e winter and time for Chrys to be lying too.

It is only when talking with cerain people that the words come to ell of the fascination, sometimes the error, and always the beauty of havng shared an eyrie with a golden agle.

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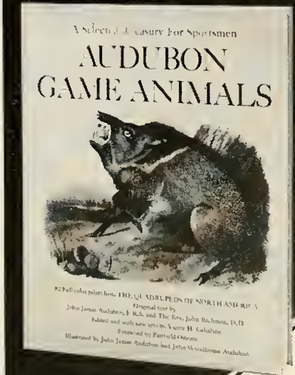

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Dispatch

HOMELAND: A REPORT FROM THE COUNTRY, by Hal Borland. *J. B. Lippincott Co., $4.95; 192 pp.* OPEN HORIZONS, by Sigurd F. Olson. *Alfred A. Knopf, $5.95; 215 pp., illus.*

Hard by the Housatonic River in a valley in the Berkshires, in northwestern Connecticut near the Massachusetts border, there stands a red farmhouse by a towering Norway spruce: on the second floor in the northwest corner in front of an electric typewriter sits Hal Borland, the favorite of many a nature watcher and/or writer.

Across the hall, when she is not making borscht or popovers or rivergrape jelly, or preparing some of the Borland harvest for three freezers and two refrigerators, is his wife, Barbara Dodge Borland, also a writer and a specialist in family gardens and, thus, nature.

Each supplements the other, as you can see by the following poem that Hal Borland has written for his wife and their togetherness and rapport with nature. It leads off his newest book, *Homeland*, and it is entitled, "*For Barbara.*"

> When I must leave, I pray it will be
> May
> For I'd remember earthly things
> this way:
> An apple tree in bloom, the breath
> of dawn,
> An oriole's ecstasy, a dappled fawn,
> A whippoorwill at dusk, I would
> hereafter
> Remember now in terms of your
> sweet laughter.

Hal Borland writes so many books you are inclined to wonder when he gets time to be a nature watcher.

But that he surely is.

There is something about him that makes you think of him as a sort of a Peter Rabbit, ever, ever curious, a man who finds his own facts and doesn't get them out of books.

For example: On a snowy night he listened to the bark of a red fox, and the next day near dawn, puffing his pipe, he was out tracking him.

The tracks of the fox led to a little-used railroad spur where the fox, like a fun-loving boy, left the snow and
started walking on one of the rai
balancing precariously. Eventually
slipped off, as was shown by the trac
in the snow, but got back on again a
continued its balancing act till it g
bored and trotted up the mountain
hind the writer's house.

There have probably been a tho
sand similar episodes, one would gue
and you can tell when you read
new book.

Perhaps the best way to describe t
book is to quote the author. He puts
this way in his foreword:

"What can a man believe in? I su
pose it depends on what a man is loo
ing for, but I know that if you watch
nesting bird and experience a mi
summer dawn, you can't fail to belie
in something. In life and time, if not
ing else. Given those, almost anythi
is possible that a rational man mig
want.

"That, to me, is the key. This bo
represents a search for the substan
of a belief that will satisfy the ques
ing mind of a rational man. I ha
found it in a nesting bird, a midsumm
dawn, a winter snowstorm, and a gre
many other things seen and heard a
felt, and to some degree understoo
from here in my rural dooryard a
out in the meadows and up on t
wooded mountainside. That really
what these dispatches are all about."

The book goes on to be a sort
soliloquy, the philosophical musings
a man who could be puffing his pipe
the side of his Franklin stove, or at
would-be, but nonexistent, cracker ha
rel in his town, Salisbury, Connecticu

So, what do you get in this book?

A fine slice of Americana that r
grettably is disappearing steadily, b
one you wish could go on forever.

Turn these pages, and you will g
vicariously the smell of apple blossom
ripening tomatoes, the rumble whe
the heavy snows cave in the aba
doned chicken coops, the jingle-bel
like calls of the spring peepers—bir
that sing before sunup, then take
pause for more song that sometime
but not always, comes as an enco
after the full dawn—the bark of t
fox, the wind soughing in the Norwa
spruce, the murmuring of a brook, t
sweet call of our disappearing blu

m the Unpaved World

by John C. Devlin

ds, the gabble of Canada geese, the aking up of the river ice.

lso there are such words as equi- x and solstice, which mark certain nges of seasons; a vanishing piece farmland property called the root lar, which, of course, is a sort of a -electronic age refrigerator; and les. Spiles? You can get them in ne New England hardware stores. It a sap spout for tapping the sap of sugar maple, whose great stands some reason are called "sugar sh."

The author, who was born Harold en Borland on May 14, 1900, in Ster- g, Nebraska, is the man who writes se charming nature essays in the torial pages of the Sunday *New rk Times* and who became charmed the east, and Salisbury in particular, ause of the abundance of water that never knew as a lad in the west. He worked on many newspapers and ious press associations, and is not mored of cities. But, let's quote him.

'Being a countryman by choice," he ites in his book, "I have certain ses in favor of the country. I moved e because I wanted to, and I stay e because it provides a good way of in a place where I can make a ing. So, perhaps I see things in a ferent light than a noncountryman. elieve that the country—the uncul- ated land and the remaining rem- nts of wilderness as well as the mland—is essential to the whole tion's sense of proportion and its rspective.

"It represents elbow room, proves at there are still places on earth ere a man can stretch his arms and gs and maybe even his mind. It presents a kind of freedom, personal edom, that is not too common a mmodity any more: freedom from chanical din, freedom from crowds, edom from mass mores and opinions. represents such minor but important edoms as the right to wear old thes or drive a car more than two ars old without worrying about social tus, the right to sit and think, or just sit, and not be labeled antisocial or urotic."

Hal Borland's love for the land al- ys comes through in all his books.

It is also a happiness to report, too, about another very pleasant book, *Open Horizons*, by Sigurd F. Olson, another old favorite.

For those who do not already know this other veteran nature writer—mostly of the northlands for all these decades—one need know principally that listening untiringly to the pipes of Pan has been his vocation and avocation.

He has heard them playing softly in settings of forests, streams, alder thickets, bogs, jewel-like pools, island lakes, headlands and fernlands, from a canoe, and by a tidy little campfire.

It was Pan, we can remember, who, in Greek mythology, was the half-man, half-goat revered as god of pastures, forests, flocks, and herds.

And of course there is the legend that at the time of the Crucifixion, just when the Veil of the Temple was split, many said they heard a cry that swept across the sea: "The great god Pan is dead."

This author, as he makes very clear here, knows that Pan is not dead, though he is having his troubles these days minding nature as he plays his pipes—sometimes dolefully but always hopefully as times and things change, seemingly for the worse.

The writer is lyrical, an asset not too common among nature crusaders. Vicariously, he takes you by the hand on his trips during a lifetime, through an invisible door into nature's realm and its many majesties. He has a good eye, a good ear, and expert knowledge.

He hunts and fishes for food, as he has since his boyhood days, at first to stock the family larder as the son of a minister, later—when he was not taking school pupils out on nature walks—for his own family, and then, as that very professional type of northlands canoe guide who holds the special title "voyageur."

There are some things here that may trouble you—the use of wire snares and of strychnine and potassium cyanide by some of his associates for "predator control," which so often these days has been described as a pointless and needless boondoggle. After all, if nature is left alone without man's meddling and thirst for profit, it will maintain its own balance as it did long before man made

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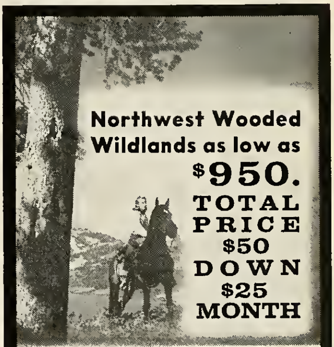

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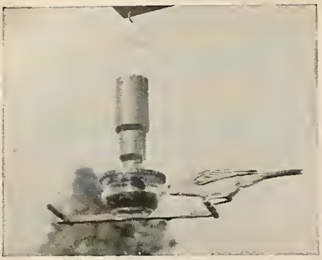

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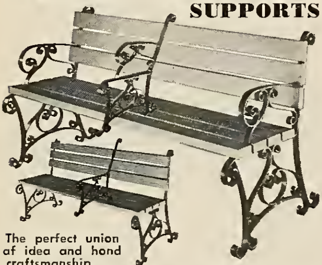

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his appearance as the prime predator. (If nature were to hold a council of war, it might poison man.)

In any event. the author is charmed most by that lovely line, "The enchantment of tranquility." And he concludes his book with a philosophical discussion of "an ecological crisis which threatens our survival." He says:

"Waters once clean have become sewers, air poisoned with noxious wastes. soil impregnated with harmful chemicals, the surface of the land befouled with garbage and the enormous effluent of civilization."

There is not much new in that, but maybe it will reach some new eyes and ears anyway.

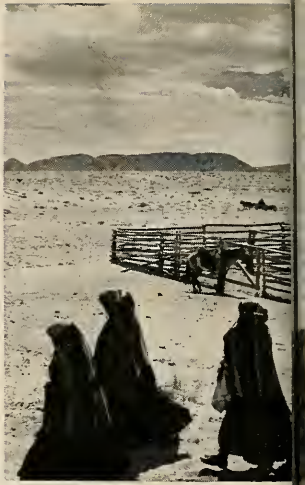
What the author seems to be saying is that civilization, which is trying in various ways. should establish a sort of a "Let's Plan for the Future Committee" for both man and nature. Maybe there should be a special cabinet post in the federal government, akin to the Department of Defense, but this one devoted solely to Nature and Man, even though this might upset some heads of the Department of the Interior. It would be very explicit and favor the majority; not the exploiters, who have their rights too in our economy, but not to devour and despoil.

John C. Devlin is a writer for The New York Times *who specializes in natural science articles. He is also a "countryman" by choice and makes his home in Connecticut.*

ALMOST ANCESTORS: THE FIRST CALIFORNIANS, by Theodora Kroeber and Robert F. Heizer. *Sierra Club Books, $15.00; 168 pp., illus.* THE ENDURING NAVAHO, by Laura Gilpin. *University of Texas Press, $17.50; 263 pp., illus.*

Handsomely produced collections of remarkable photographs of American Indians are featured in *Almost Ancestors* by Theodora Kroeber and Robert Heizer, as well as in Laura Gilpin's *The Enduring Navaho*. These will be prized and leafed through again and again by those who enjoy contemplating characterful, interesting faces and the life and living they reflect. Despite the similarity of subject and format, however. these are quite different books, embodying different authors' experiences and orientations, and meant to evoke different responses from the reader.

The Sierra Club, which published *Almost Ancestors*, is famous for its work in conservation and thus, while understandable, it is unfortunate that the Foreword by the Executive Director of the organization, David Brower, implies that the problems of the Ame
can Indian are somehow of a kind wi
the whooping crane and passeng
pigeon. While Kroeber and Heizer a
properly ethnological. the initial i
pression of analogies between societi
and cultures and extinct and threa
ened species is reinforced by the abi
ing theme of their text. stressing cas
of outright genocide and the general
dismal effects of white contact on t
Indians of California. Unless the read
pays close attention. he is apt to mi
the fact that due to accidents of hi
tory and geography there are at lea
some California Indian groups. li
many Indian communities across t
country, who are not vanishing in pa
sive Darwinian fashion, but are mana



from Navaho life, at left,
te The Enduring Navaho.
dramatic Mohave Indian
t is from Almost Ancestors.

purposefully to maintain their in-
rity and identity by selective and
licious adaptations in regard to the
minant white society and culture.
The heart of the book, however, is
photographs from museum archives
d private collections that have lain
retofore unknown and unappreciated
cept by a handful of experts. Out of
me 400 photographs located, the
thors have selected 117 particularly
mpelling pictures for reproduction.
e greatest share was taken from
out the turn of the century. They are
ouped by culture area and accom-
nied by succinct and genuinely
etic captions. The text, written with
nsitivity and affection, notes regional
fferences in physical types, world
ew, mythology, distinctive aspects of
lture, life history data on subjects
here these are known, and always the
agic results of white contact. Al-
ough the vanishing Indian theme may
overdrawn at times, the destruction
native life is particularly shocking
the case of California because of its
cency, extent, and swiftness, a fact
history poignantly told in Kroeber's
rlier book, *Ishi in Two Worlds*, the
ccount of the last survivor of the
ahi. Ishi's picture, fittingly, is the
nal illustration in *Almost Ancestors.*

As the title of *The Enduring Navaho* indicates, the theme of Gilpin's book is quite different from that of Kroeber and Heizer. Far from vanishing, the Navaho are now the largest North American Indian tribe, and their population continues to increase. The photographs were taken by the author over a period of thirty years, and the text speaks directly, in the first person, of experiences with the subjects and events shown. Despite the personal familiarity of the author with the people depicted and a sense of optimism rather than tragedy. *The Enduring Navaho*, as much as *Almost Ancestors*, conveys something uniquely and ineffably Indian that continues to fascinate, mystify, and enthrall, whether the reader be wide-eyed Boy Scout or professional ethnologist schooled in objective study of peoples and their cultures. In another thirty years, some of the scenes and faces captured by Gilpin's lens will be as precious historical documents as the old pictures from California. Gilpin, however, makes a convincing case that these will not be viewed as a record of a vanishing people and culture. The Navaho have changed markedly over the generation she has known them, but as her excellent text notes, they have been changing and adapting since they first wandered down from the North into the Southwest. Borrowing and innovating to survive and increase, they endure as *Navaho.* Gilpin has actually produced a book for two popular audi-

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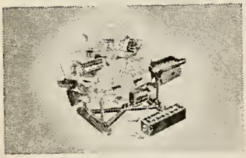

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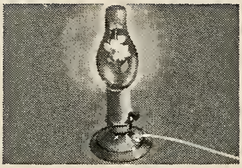

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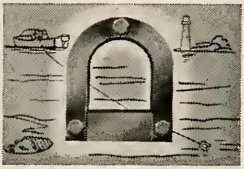

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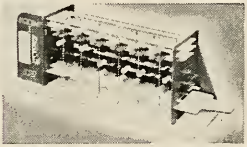

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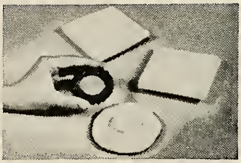

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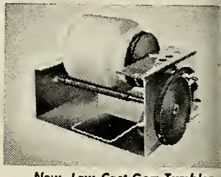

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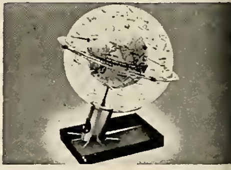

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es: people who like to look at tures and browse among charming nettes of the subjects, and people ɔ also want hard facts systematically sented. She makes no apology as presents the Navaho origin myth its esoteric complexity or gives a ailed description of the Navaho m and techniques of weaving. The vaho are worth knowing and for se willing to make the effort, Gilpin kes sure they will know them well.

There may be criticism from old vaho hands that Gilpin puts a too y construction on the history of conts and problems in Navaho-white ations, seeing the whites as merely sguided in their good intentions, n in encounters that were callously el and deeply tragic for the Navaho. wever, this kind of disposition also rmits Gilpin to rise above the power litics on the Navaho Reservation, ich often overwhelm and thoroughly may outside observers who feel they ist take sides or at least deplore the uation. Knowing the Navaho have mately triumphed in past periods of sis, Gilpin apparently considers the igious and political factionalism, d even the material poverty stressed so many popular accounts of the ıvaho, as variable compared to what strong and durably Navaho. They e expectable in the experience of a ople constantly grappling and exrimenting with new ideas to best sband tribal resources and adminisr to a rapidly increasing population at is, furthermore, differentially aclturated from place to place on the servation. It is clear from her text at she knows very well what is going . Thus, some of the seemingly curiıs omissions must be accepted by prossional Navaho experts as admirable llingness to leave Navaho squabbles the Navaho. Even the dearest of iends have their exasperating moents, but it is hardly polite to make point of these in introducing them to rangers.

NANCY OESTREICH LURIE
University of Wisconsin

riefly Noted:

EREGRINE FALCON POPULATIONS, eded by Joseph J. Hickey. *The University of Wisconsin Press, $10.00; 596 p., illus.*

This book is the outgrowth of an inernational conference of naturalists, ientists, and conservationists that et at the University of Wisconsin to ıvestigate the causes of the catasrophic decline of Peregrine Falcon opulations in North America and Euope. Other findings of the conference re also described in the volume: the iology of Peregrines, certain corollaries in the decline of other birds of prey, and the comparative status of regional Peregrine populations in North America, Canada, Mexico, and Europe. Excellent photographs accompany the text.

A WORLD FULL OF ANIMALS, by John Hunt. *David McKay Co., $6.95; 378 pp., illus.*

As community relations director of the Los Angeles Zoo, John Hunt has a breezy and anecdotal story to tell of the life behind bars. His inspiration for this book was the curiosity of zoo visitors about the natural history of the reptiles, birds, mammals, and amphibians housed there. Mr. Hunt provides an enormous amount of information about animals, both in captivity and in their natural state, with a few observations on some unfortunate traits they share with man. (According to the author, chameleons are emotionally unstable and elephants hold grudges for years.) C. B.

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and Adjacent Tropical Waters

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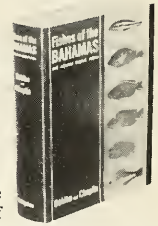

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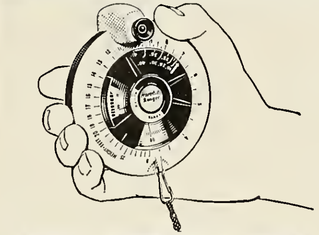

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UNDER THE SPELL OF THE ZODIAC

A History of Astronomy from Thales to Kepler. J. L. E. Dreyer. Dover Publications, New York, 1953.

A History of Magic and Experimental Science. L. Thorndike. 8 vols. Columbia University Press, New York, 1923-1958.

Medieval and Early Modern Science. A. C. Krombie. Anchor Books, New York, 1959.

THE SHREDS OF ANCIENT PERSIA

History of the Persian Empire. A. T. Olmstead. University of Chicago Press, Chicago, 1948.

Persia, From the Origins to Alexander the Great. R. Ghirshman. Thames and Hudson, London, 1964.

The Heritage of Persia. R. N. Frye. World Publications, Cleveland, 1963.

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The Vicuña and the Puna. C. B. Koford. *Ecological Monographs,* Vol. 27, No. 2, April, 1957.

The Extermination of the Vicuña. M. Bate. *Animals Magazine,* Vol. 11, No. 2, June, 1968.

An Historical and Descriptive Account of the Peruvian Sheep. W. Walton. London, 1811.

SUPERFLEA MEETS MOUNTAIN BEAVER

A Review of the Literature on the Mountain Beaver. A. J. Godin. U. S. Fish and Wildlife Service, Special Scientific Report—Wildlife, No. 78, 1964.

Fleas of Western North America. C. A. Hubbard. The Iowa State College Press, Ames, 1947.

ARCTIC WALK

Wildlife in Alaska. A. S. Leopold and F. F. Darling. Ronald Press, New York, 1953.

Two in the Far North. M. E. Murie. Alfred A. Knopf, Inc., New York, 1963.

Alaska: A Challenge in Conservation. R. A. Cooley. University of Wisconsin Press, Madison, 1966.

MUSSELS ON THE MOVE

The Fresh-water Mussels of Illinois. P. W. Parmalee. Illinois State Museum. Popular Science Series, Vol. 8, 1-108, Springfield, 1967.

Downstream: A Natural History of a River. J. Bardach. Grosset and Dunlap, New York, 1964.

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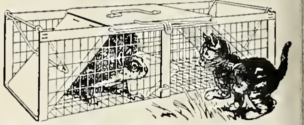

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THREE KINGDOMS OF THE HIMALAYAS

BHUTAN — SIKKIM — NEPAL

November 4th to December 2nd, 1969

Led by Mr. M. A. Badshah, an Indian friend of ours, who has led several of our tours on the Indian sub-continent. Mr. Badshah is a high Indian government official, an internationally known conservationist with a broad range of cultural interests and a charming personality.

BUTHAN, or Druk Yul, the land of the dragon, is a Tibetan country. Culturally it is like Tibet before the Chinese invasion. The Drukpas or Buthias are of Tibetan stock, their language is closely related to Tibetan. The state religion, Mahayana Buddhism, came from Tibet, and the spectacular castle monasteries, Buthan's most remarkable architecture, are built in the style of Lhasa. The monasteries are cultural centres of religious theater and dances and of arts and handicraft, in particular wood-carvings and metal work. The capital, Thimbu, is in the Paro Valley of the Inner Himalayas. It is reached from Silinguri in Bengal, a day's travel by car. Before the road was built, in 1962, the journey took 6 days, on mule tracks. There will be excursions from Thimbu, visits to monasteries, ceremonies, dances, perhaps an archery contest and an audience with the royal family. In due course we will mail our own travel report to the participants. In the meantime, the easiest accessible literature would be an article in National Geographic, Sept. 1961, by Desmond Doig, with beautiful photographs.

SIKKIM is a small country of high mountains and deep valleys. It has more than a dozen peaks of over 20,000 feet. Most people are Tsongs of Nepalese descent but there are also Lepchas and Buthias. Sikkim's capital, Gangtok, is reached from Darjeeling.

NEPAL, often visited on our tours, is reached by air from Benares. The greatest attraction in all three kingdoms are, of course, the Himalayas, but the towns of Katmandu Valley are rich in great art and architecture. An air excursion will lead to Pokhara.

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FADA, centre of the Ennedi, on the southern border of the Sahara. 500 sites of prehistoric paintings, discovered in 1957 by the Musée de l'Homme. Most sites accessible by car. The people of the Ennedi: the nomadic Tibbu and the farming Bideyat. Interesting fauna and flora: mini-crocodiles, masses of land turtles, berber lions, giraffes, birds.

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Natural History

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When carefully done, this did little or no harm to aquatic life. But fish were sometimes scared and fled to quieter waters. Fishermen frowned. They had to go farther to fish.

Now, the Esso Production Research Company (a Jersey affiliate) has invented a substitute for dynamite. We have nicknamed it the popp and you can see one at the bottom of our p ture. It doesn't go bang like dynamite. It simp goes pop.

The device is beautifully simple. A m ture of propane and oxygen is ignited by spark plug inside a rubber sleeve. The p inflates the sleeve like an instant balloon.

This sudden expansion is fast enough give a seismic echo, but not fast enough

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simple. A
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are away fish, porpoises or anything else.

What's more, it has a snorkel. This allows urned gases to escape to the surface. So the ater stays clean.

But fishermen aren't the only people to heer.

Dynamite is often tricky stuff to handle. he popper is completely safe. Exploration rews have one less danger to contend with.

And dynamite is also quite expensive. Fifteen dollars a shot. The popper costs a penny a pop and gives a better seismic picture in the bargain. At the rate the oil industry is exploring, it could literally save millions.

Good news for people. Great news for fish. Quite an invention.

Standard Oil Company
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VOL. LXXVIII, No. 6 JUNE-JULY

Natural History

JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

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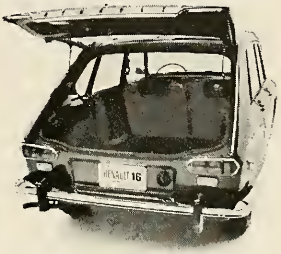

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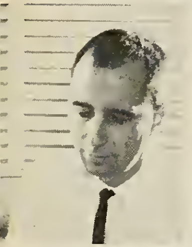
Wilbur S. Tripp

Herbert W. Pohle

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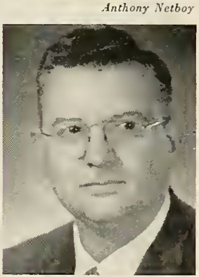
Syd Rodinovsky

Kurt Severin

Anthony Netboy

S. I. Rasool


Roger A. Morse

An Exaltation of Larks, according to its author, James Lipton, "began as a kind of hobby that grew into a passion and finally a book"—an excerpt of which appears this month. Mr. Lipton, a published poet at twelve, subsequently became a professional actor, appearing on Broadway, in films, and on television. He is the author of two Broadway musicals—the most recent, *Sherry!*

This month's "Naturalist at Large," Garrett Hardin, is Professor of Biology at the University of California at Santa Barbara. Concerned with what he terms the "humanistic bearings of biology," Dr. Hardin began his career in the field of experimental microbiology, moved toward genetics and evolution, and is now involved with questions relating to the cultural, ethical, and emotional values of scientific thought. Dr. Hardin's article will be included in the forthcoming book *Wilderness, the Edge of Knowledge*, to be published by the Sierra Club.

Grand Prize winner of Natural History's photo contest, W. S. Tripp is a dentist in Medicine Hat, Alberta. His prizewinning picture of the adult *Bubo* was taken at one of the many nests he has photographed in his travels (he covers more than 24,000 miles each year). Moments before, the bird had dived at him, raking her rear talons through his hair—six sutures were needed to repair his scalp.

Another amateur ornithologist, H. W. Pohle was awarded First Prize for his black-and-white photograph of the egret. Dr. Pohle, a physician, often "bird hunts" with his camera in the Kettle Moraine area and the adjacent Horicon Wild Life Refuge, both near his Milwaukee home.

Since we had known Syd Radinovsky, author of several articles for Natural History, primarily as an entomologist and writer, we were delighted to learn that the judges had awarded him First Prize in Color. Dr. Radinovsky finds photography an important teaching aid in his position as a professor of biology at Millersville State College.

George L. Downing's interest in southwestern Indians and their crafts has taken him "pueblo tr
ting" for many years. A biolo
teacher in the Colorado pub
schools, Mr. Downing has been
seasonal naturalist in Yellowsto
National Park for eighteen seaso
He is now the supervisory natural
at the Grand Canyon Station.

Although Kurt Severin is not
herpetologist, he has probably e
countered more serpents on h
travels than have many experts.
travel- and feature-reporter, M
Severin's experiences have includ
befriending snake-drug makers
Hong Kong, witnessing a cobra-b
cure in an Indian shrine, and testi
snake-derived aphrodisiacs. He h
also participated in more conventio
al serpent observations.

Since 1953, when he was a mem
ber of the Columbia Basin Inte
agency Committee, Anthon
Netboy has been involved with t
conservation of salmon. The auth
of *The Atlantic Salmon: A Vanis
ing Species?* and of *Salmon of t
Pacific Northwest*, Mr. Netboy
currently writing *Man and the Sa
mon*, from which his article is adap
ed. A professor of English with t
Oregon State System of Higher Ed
cation, Mr. Netboy collected t
material for his article during exte
sive travels in the Pacific Northwe
and a brief visit to Alaska.

A coexperimenter on the Marin
5 mission to Venus in 1967, Dr. S.
Rasool writes of new conceptions
that planet based on recent probe
Dr. Rasool, whose primary study
the atmospheres of other planets,
a planetary physicist at the Godda
Institute for Space Studies, Nation
Aeronautics and Space Administr
tion.

"The Varied Fare of the Hone
bee" is one of more than 150 popu
lar and technical articles Roger A
Morse has written on bees. D
Morse, Associate Professor of Ap
culture at Cornell University, ha
done research on stinging insects i
Southeast Asia, on the biology o
Asian bees in the Philippines, an
on reproduction of honeybees i
Florida. He is also a home win
maker, a hobby that led to his mas
ter's thesis on the manufacture o
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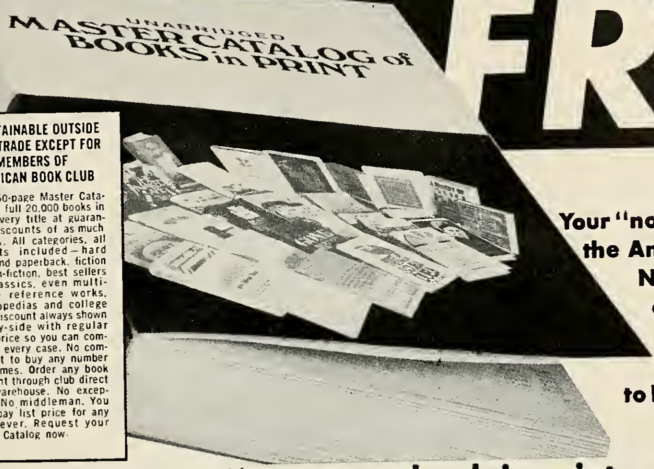

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Letters to the Editors

Again the Peaceful Atom

The story entitled "The Myth of the Peaceful Atom" in your March, 1969, issue has just come to my attention. Since the authors have quoted, in questionable context, some of the remarks I made before the Health Physics Society in Augusta, Georgia, last year, I hope that you will permit me to make a few observations that may provide some objectivity to the discussion of nuclear safety.

For example, I am quoted as describing the release of tritium and noble gases such as krypton-85 from chemical processing plants as posing a potential problem in the future, and that "as yet scientists have not devised a way of solving it." I discussed tritium and krypton-85 in the context of a discussion of the advantages nuclear power plants present in relieving the air pollution problem that we might otherwise have to cope with if the thermal electric generating plants that this country will require over the next two or three decades were all to be fossil-fueled plants.

I made an important additional point—that coal-burning plants release more biologically significant radioactivity to the atmosphere than do nuclear plants. With respect to tritium and krypton-85, I went on to say that as the nuclear industry grows, we must continue to vigilantly control the release of radioactivity. I assure you that this will be done.

The authors also quote my statement that it is necessary to contain and isolate the high-level wastes from reprocessing of reactor fuel for 500 to 1,000 years "a period which is longer than the history of most governments that the world has seen."

The authors did not go on to report, as I did in my speech, that our high-level waste-handling methods have proved safe, but that for the longer pull we are conducting a vigorous research and development program to solidify these wastes, both to reduce their volume and to permit long-term storage in isolated areas such as abandoned salt mines where the costs and problems of maintenance can be obviated.

These are but a few of the examples where the authors of your article have told only part of the story. I am sure you will agree that judgments should be made on the basis of the whole story.

Let me just add one more thought. The nuclear industry is unique in that the potential hazards associated with the use of radioactive materials were realized from the beginning and stringent precautions were taken.

As AEC Chairman Glenn T. Seaborg said recently, " . . . Sixteen reactors constructed for the generation of electric power have compiled a record of about 90 reactor years of operating experience without exposure of any member of the public to harmful quantities of radiation. This record, we feel, results from the degree of safety consciousness that has been demonstrated by the industry, the utilities involved, the Joint Committee on Atomic Energy, and the AEC. We are confident that all concerned will exert every effort to maintain the high standards that are required to perpetuate this record. . . ."

WILFRID E. JOHNSON
Commissioner,
Atomic Energy Commission

I read with great interest the article "The Myth of the Peaceful Atom," by Richard Curtis and Elizabeth Hogan, in the March, 1969, issue of NATURAL HISTORY. As an executive with the research and development division of a company that is a leader in the engineering and manufacture of both fossil-fueled and nuclear-fueled power generation equipment, I should like to compliment you and the authors on this article. Most articles directed to the lay public, which focus on the hazardous aspects of nuclear power, are written by persons who are either ignorant or who are deliberately distorting the situation for one of several reasons. In my judgment Richard Curtis and Elizabeth Hogan have done a remarkable job of researching this subject and presenting their material accurately and fairly.

Clearly, they are building a case for the hazards involved in nuclear power, and I believe that there are other aspects of the nuclear power story that should be set forth to give a completely balanced point of view. However, I was pleased to read their article, and I feel that it sustains the high quality of NATURAL HISTORY magazine.

NAME WITHHELD
ON REQUEST

I was staggered by the Curtis-Hogan article, "The Myth of the Peaceful Atom," in your March issue, particularly because I live in an area soon to be surrounded by nuclear power plants. A large facility is now under construction at Zion, Illinois, just the north.

I have been active in the fight agai the ABM here, and am a member of group called "The Committee on La Michigan Pollution." Just last night had a meeting at which we question an official of the Illinois Pollution Co trol Board on the Zion plant situati and potential dangers to the lake a surrounding communities. We were f from satisfied with his statements. H admits that there will be some radioa tive discharge into the lake.

Are reprints of the Curtis-Hoga article available to our group? W would like to send such reprints to o membership and make them availab to others as well, hoping to genera public concern about the Zion pla and the six additional plants that wi be built on Lake Michigan in the ne ten years.

Thank you for printing this articl and for the fine work that you do in a your issues.

HERBERT K. KAN
Glencoe, Illino

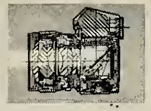
City of Prophecies

In the April, 1969, "A Naturalist Large" I found Edward Abbey's pu gent prose and presences to hav brought a new, important, and som what overdue wrinkle to the canvas nature and its history as portrayed b your publication.

Should we choose to view our natura world mainly from the academic cloisters of science, there is little doubt tha our fund of knowledge will grow. Ye there would still remain an annoyin imbalance to the total picture, a larg gap between the emotional world w feel, live in, react to, and the definabl world of the microscope and the statistic. This latter viewpoint is what presently instills in us great confidenc when dealing with technological problems (space travel, napalm), but elicit a bewildered shrug when faced wit ghettos, population control, and th dilemma of the total human condition

It will only be through a keene sense of ambience and insight—to loo afresh at all that we have grown use to—that we can hope to understand an appreciate the best of our natura world and begin to correct the worst o our man-made environment. "City o Prophecies" is a step closer to that end

ROBERT BELOU
Pacific Palisades, Californi



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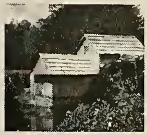

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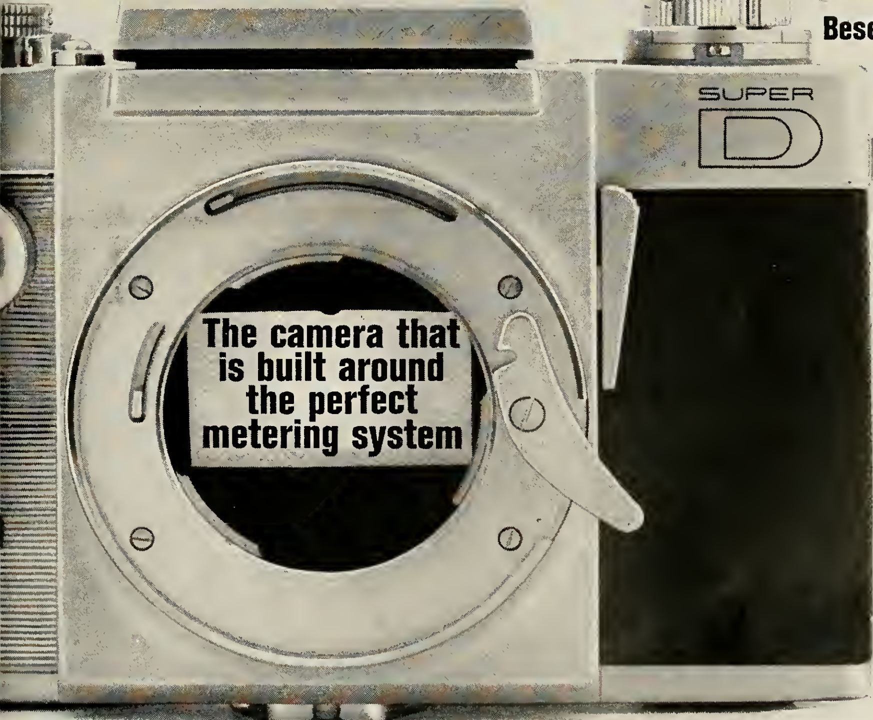

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An Exaltatio

In 1906, having rid himself once and for all of Holmes and Watson, Sir Arthur Conan Doyle returned to the literary form with which he had begun his career fifteen years earlier, producing an historical novel, *Sir Nigel*. In it the young Nigel comes under the tutelage of Sir John Buttesthorn, the Knight of Dupplin, head huntsman to the King, and England's greatest authority on the hunt. In Chapter XI, the sublimely immodest old knight says to Nigel: "I take shame that you are not more skilled in the mystery of the woods, seeing that I have had the teaching of you, and that no one in broad England is my master at the craft. I pray you to fill your cup again whilst I make use of the little time that is left to us."

There follows a lengthy disquisitio the chase, "with many anecdotes, illustrations, w ings and exceptions, drawn from his own great ex ence" and finally the knight says, "But above all I you, Nigel, to have a care in the use of the terms o craft, lest you should make some blunder at tabl that those who are wiser may have the laugh of you, we who love you may be shamed."

"Nay Sir John," said Nigel. "I think after your teaching I can hold my place with the oth

The old knight shook his white doubtfully. "There is so much to be learned that t is no one who can be said to know it all," said he. " example, Nigel, it is sooth that for every collectio

f *Larks* *by James Lipton*

Excerpted from An Exaltation of Larks, *Grossman Publishers, Inc.,*
Copyright © 1968 by James Lipton

ts of the forest, and for every gathering of birds of ir, there is their own private name so that none may onfused with another."

"I know it, fair sir."

"You know it, Nigel, but . . . none can hat they know all, though I have myself pricked off y and six for a wager at court, and it is said that chief huntsman of the Duke of Burgundy has ted over a hundred . . . Answer me now, lad, how d you say if you saw ten badgers together in the t?"

"A cete of badgers, fair sir."

"Good, Nigel—good, by my faith! And if walk in Woolmer Forest and see a swarm of foxes, how would you call it?"

"A skulk of foxes."

"And if they be lions?"

"Nay, fair sir, I am not like to meet several lions in Woolmer Forest."

"Ay, lad, but there are other forests besides Woolmer, and other lands besides England, and who can tell how far afield such a knight errant as Nigel of Tilford may go, when he sees worship to be won? We will say that you were in the deserts of Nubia, and that afterward at the court of the great Sultan you wished to say that you had seen several lions . . . How then would you say it?"

". . . Surely, fair sir, I would be content

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to say that I had seen a number of lions, if indeed I could say aught after so wondrous an adventure."

"Nay, Nigel, a huntsman would have said that he had seen a pride of lions, and so proved that he knew the language of the chase. Now, had it been boars instead of lions?"

"One says a singular of boars."

"And if they be swine?"

"Surely it is a herd of swine."

"Nay, nay, lad, it is indeed sad to see how little you know . . . No man of gentle birth would speak of a herd of swine; that is the peasant speech. If you drive them it is a herd. If you hunt them it is other. What call you them then, Edith?"

"Nay, I know not."

". . . But you can tell us, Mary?"

"Surely, sweet sir, one talks of a sounder of swine."

The old knight laughed exultantly. "Here is a pupil who never brings me shame! . . . Hark ye! Only last week that jack-fool, the young Lord of Brocas, was here talking of having seen a covey of pheasants in the wood. One such speech would have been the ruin of a young squire at court. How would you have said it, Nigel?"

"Surely, fair sir, it should be a nye of pheasants."

"Good Nigel—a nye of pheasants, even as it is a gaggle of geese or a badling of ducks, a fall of woodcock or a wisp of snipe. But a covey of pheasants! What sort of talk is that?"

What sort indeed! This quotation from Conan Doyle makes, for me, the central point . . . the terms you will discover here are genuine and authentic; that is, each of them, as fanciful—and even frivolous—as some of them may seem, was at one time either in general use as the *only* proper term for a group of whatever beast, fish, fowl or insect it designated, or had acquired sufficient local currency to warrant its inclusion in a list with the well-established hunting terms.

Bear in mind that most of these terms were codified in the fifteenth century, a time when the English language was in the process of an expansion—or more accurately, explosion—that can only be compared in importance and scope to the intellectual effusions of Periclean Greece or cinquecento Italy. *The Egerton Manuscript*, the earliest surviving list of them, dates from about 1450; *The Book of St. Albans*, the most complete and important of the early lists (and the seminal source for most subsequent compilations), appeared in 1486. I have avoided giving a single, comprehensive collective term to these collective terms. That is because there isn't any. Oddly enough, the compilers of the numerous lists of these words, though

PELICULAR PENINSULA
REWIND ROCK
ASA MESA
NUMERUS EXPOSIPUS
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obviously enthusiastic philologists, have never felt compelled to settle on a group term for them. The explorer in this field will find these words variously referred to as "nouns of multitude," "company terms," "nouns of assemblage," "collective nouns," "group terms," and "terms of venery." This last seems to me best and most appropriate, and itself warrants some explanation.

"Venery" and its adjective, "venereal," are most often thought of, of course, as signifying love, and more specifically physical love. From *Venus* we have the Latin root *ven* which appears in the word *venari,* meaning "to hunt game." Eric Partridge, in his etymological dictionary *Origins,* asserts that the *ven* in *venari* has its original meaning: "to desire (and therefore) to pursue," and he sees a close connection between it and the word "win," from the Middle English *winnen,* and even the Sanskrit *vanoti,* "he conquers." It is in this sense that venery came to signify the hunt, and it was so used in all the early works on the chase, including the earliest known on the subject of English hunting, *Le Art* [sic] *de Venery,* written in Norman French in the 1320's by the huntsman of Edward II, Master William Twici.

So, if all the earlier and far greater experts in this field have left it to someone of the twentieth century to select the proper term for these proper terms, I (cautiously and with boundless and well-founded humility) pick up the gauntlet and declare for "terms of venery"; if for no more cogent reason than that it allows of such disingenuous derivative delights as "venereal," "venerealize," and "venerealization." The fact that many of the terms of venery have slipped out of our common speech can only, I think, be described as lamentable. There is little enough poetry in our speech (and lives) to continue to ignore a vein as rich as this. My purpose is to try, in an admittedly modest measure, to redress the balance. My thesis can be summed up very simply: when a group of ravens flaps by, you should, if you want to refer to their presence, say, "There goes an unkindness of ravens." Anything else would be wrong.

A SCHOOL OF FISH

A PRIDE OF LIONS

A HERD OF ELEPHANTS

A LITTER OF PUPS

A FLOCK OF SHEEP

A BAND OF MEN

Hence also band *for a group of musicians.*

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A SLATE OF CANDIDATES

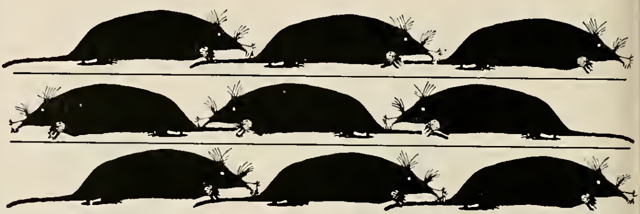
Doubtless deriving from the time when nominees' names were chalked on one.

A SWARM OF BEES

A BROOD OF HENS

A STRING OF PONIES

A LABOR OF MOLES



A COVEY OF PARTRIDGES

Here is an interesting etymological journey: the Latin cubare *means "to be lying down" (both* concubine, *to be lying down* with, *and* incubate, *to be lying down* on, *also derive from this root). It becomes* cover *in Old French, whence* cove *or* covy *in Middle English. Thus it refers to nesting habits.*

A PLAGUE OF LOCUSTS

A COLONY OF ANTS

A PASSEL OF BRATS

An American term, of course. J. Donald Adams went looking for this one, finding it finally in Wentworth's American Dialect Dictionary *as "hull passel of young ones," "a passel o' hogs," etc., but no etymology is given. My Southern friends assure me, however, that* passel *is simply "parcel" in a regional accent.*

A MURDER OF CROWS

A KINDLE OF KITTENS

Kin, kindred, *and the German* Kinder *are related to this word from the ME* kindlen. *To* kindle *literally means "to give birth."*

A COWARDICE OF CURS

A POD OF SEALS

The derivation of this word is obvious, since a pod *contains several peas. It was borrowed by sailors to describe groups of seals.*

A SLOTH OF BEARS

A RAFTER OF TURKEYS

Probably not what you think, if you see birds sitting on a beam. The term is related to raft *in the sense of "a large and often motley collection of people and things, as a* raft *of books," according to Webster. It is also* *related to* raff, *which means a collection of things, and appears in some interesting variations in* riffraff *and* raffish.

A PACE OF ASSES

From the Latin passus, *a step or stride.*

A WALK OF SNIPE

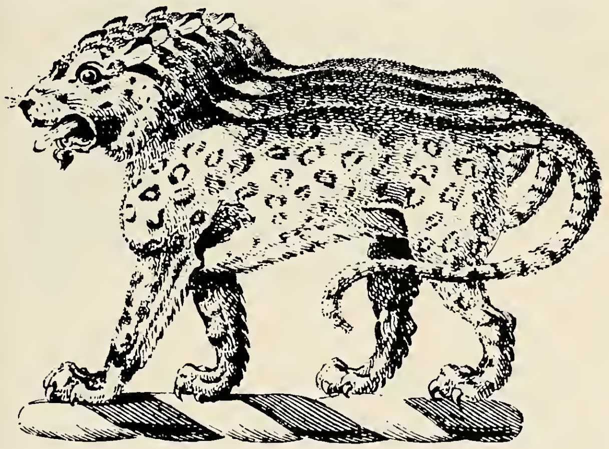
A GAM OF WHALES

A whaling voyage could last as long as three years, so when two whalers encountered each other on some remote sea, it called for a gam, *an exchange of crews via whaleboats and the "gamming chair." It was a happy time for a whaleman and, obviously, the whales' habit of sporting playfully on the surface of the sea gave rise to this fanciful term.*

A NEST OF RABBITS

A GANG OF ELK

A LEAP OF LEOPARDS



A FALL OF WOODCOCKS

A DULE OF DOVES

A corruption of the French deuil, *mourning. The soft, sad ululation of the dove has always evoked an association with mourning.*

A SKULK OF FOXES

A DISSIMULATION OF BIRDS

A PEEP OF CHICKENS

A BUSINESS OF FERRETS

A PITYING OF TURTLEDOVES

A PADDLING OF DUCKS *on water*

A BEVY OF ROEBUCKS

When applied to roes there would seem to be some support for the argument that it stems from the French word for drinking, since roes would frequently be seen together at a watering place.

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A SIEGE OF HERONS

From the way the heron doggedly waits for its prey in the shallows at its feet.

A SHOAL OF BASS

A DRIFT OF HOGS

A TRIP OF GOATS

A CHARM OF FINCHES

A SKEIN OF GEESE *in flight*

A GAGGLE OF GEESE *on water*

A CETE OF BADGERS

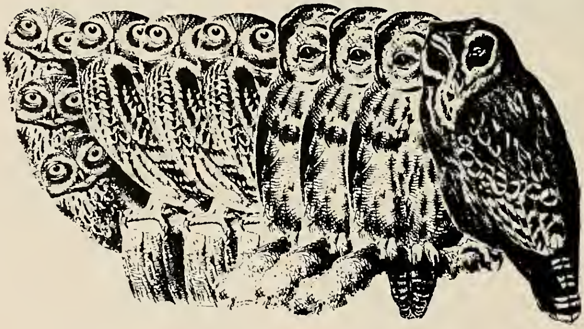
A CAST OF HAWKS

A DECEIT OF LAPWINGS

AN OSTENTATION OF PEACOCKS

A DROVE OF CATTLE

A PARLIAMENT OF OWLS



A SINGULAR OF BOARS

It seems an odd term for a company, but who are we to argue with Sir John Buttesthorn, the Knight of Dupplin?

A TIDINGS OF MAGPIES

A BOUQUET OF PHEASANTS

A CONGREGATION OF PLOVERS

A TROOP OF KANGAROOS

AN UNKINDNESS OF RAVENS

A BUILDING OF ROOKS

From their nesting habits.

A RICHNESS OF MARTENS

A HOST OF SPARROWS

A KNOT OF TOADS

A DESCENT OF WOODPECKERS

A SOUNDER OF SWINE

A MUSTERING OF STORKS

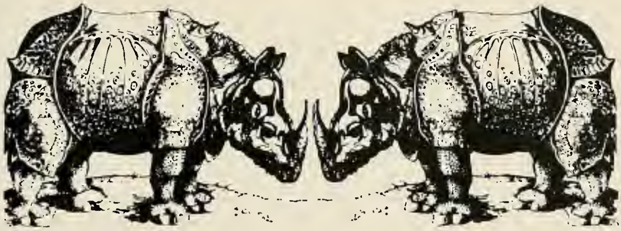
A CLUTCH OF EGGS

A DRAY OF SQUIRRELS

A Middle English word for their nests.

AN ARMY OF CATERPILLARS

A CRASH OF RHINOCEROSES



A FLIGHT OF SWALLOWS

A CLOWDER OF CATS

A truly marvelous venereal term that somehow conveys the essence of cats in a group. Hodgkin, in Proper Terms, *says that it is probably the same word as "clutter."*

A WATCH OF NIGHTINGALES

A BARREN OF MULES

The term seems to refer to their sterility, but Hodgkin suspects that barren *(or, as it appears in most of the lists,* baren*) was a corruption of the ME* berynge, *"bearing," and, in the same sense,* The Egerton Manuscript *has "a Burdynne of Mulysse."*

A SHREWDNESS OF APES

A ROUTE OF WOLVES

A MURMURATION OF STARLINGS

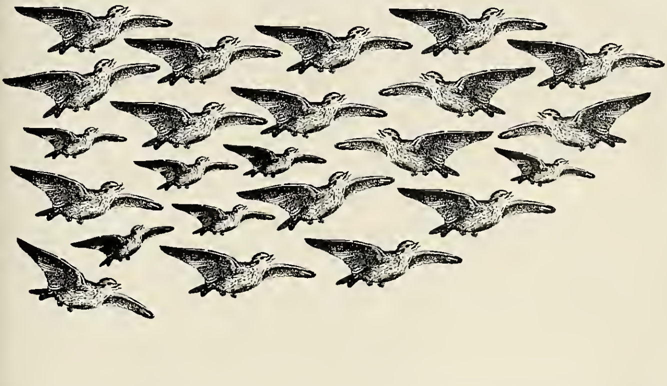
A SPRING OF TEAL

A SMACK OF JELLYFISH

A HARRAS OF HORSES

Hara *in Latin meant a pigsty, hence any enclosure for animals.*

AN EXALTATION OF LARKS



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—*William Shakespeare*

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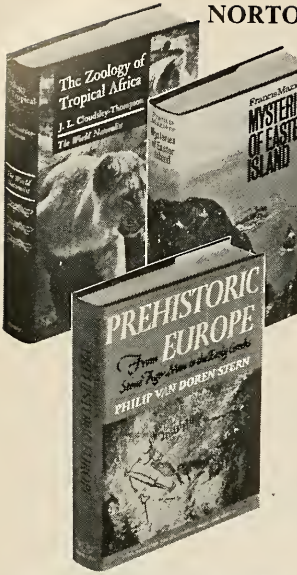

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A Naturalist at Large

The Economics of Wilderness

by Garrett Hardin

To some it may seem anathema to mention wilderness and economics in the same breath. Certainly, in the past, some of the most dangerous enemies of wilderness have been men who spoke the economic lingo. Despite this historic tar I think the brush of economics is a proper one for painting a picture of wilderness as a problem in human choice.

Economics may be defined as the study of choice necessitated by scarcity. There is something odd, and even improper, in speaking of the "economics of abundance" as Stuart Chase once did. With true abundance all economics ceases, except for the ultimately inescapable economics of time. Of the economics of time there is no general theory, and perhaps cannot be. But for the *things* of the world there is an economics, something that can be said.

Although there really is no such thing as an economics of abundance, the belief that there is, is one of the suppurating myths of our time. This belief had its origin partly in a genuine economic phenomenon, "the economy of scale." For complex artifacts in general the unit cost goes down as the scale of manufacture increases. In general, the more complex the artifact, the more striking the economy of scale: the cost per unit to build a million automobiles per year is far, far less than the cost per unit when only one is manufactured. Because artifacts are so pervasive in modern life, most of us unconsciously assume "the bigger the better," and "the more the cheaper." It takes a positive effort of imagination to realize that there are things the supply of which cannot be multiplied indefinitely. Natural resources in general, and wilderness in particular fall in this group.

This is obvious enough to Sierra Club members. It should be obvious to everyone, but it is not. Not long ago, for example, discussing some proposed improvements in a nationa park, the *Toronto Financial Pos* said: "During 1968 and early 1969 campsites will be expanded and roads paved to enable the visitor to enjoy the wilderness atmosphere that was nearly inaccessible only a few years ago." This is an astonishing sentence but I will bet that one would have to argue with the writer of it for quite a while before he could be made to see the paradox involved in speaking of building a road into the wilderness.

Wilderness cannot be multiplied and it can be subdivided only a little It is not increasing; we have to struggle to keep it from decreasing as population increases. Were we to divide up the wilderness among ever a small fraction of the total population, there would be no real wilderness available to anyone. So wha should we do?

The first thing to do is to see where we stand, to make a list of possibilities without (initially) making any judgment of their desirability. On the first level of analysis there are jus three possibilities.

1. The wilderness can be opened to everyone. The end result of this is completely predictable: absolute destruction. Only a nation with a smal population, perhaps no greater than one percent of our present population, a nation that does not have at its disposal our present means of transportation could maintain a wilderness that was open to all.

This article is based on a talk given by Garrett Hardin at the Sierra Club's Wilderness Conference, San Francisco, March 15, 1969.

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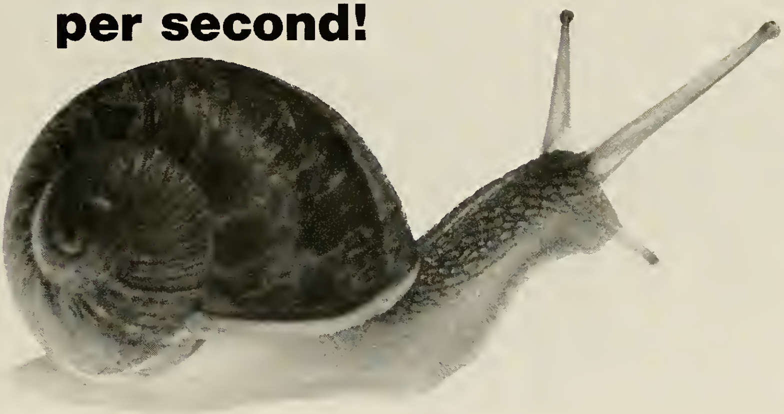

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Use Beaulieu's macro capability as the key to unlock the wondrous in the commonplace. Capture the mystery in the delicate curve of an eyelash. A raging ocean in a single drop of surf. A nuclear explosion in the glowing end of a cigarette. Plus limitless applications for educational, medical, industrial and research filming.

How much choice of motorized zoom speeds is a choice? Other Super 8's say 2 choices are enough, "Fast" and "Slow." Beaulieu says you should have more choice. So the 4008 ZM lets you set the motorized zoom at an infinite number of speeds between 2 and 12 seconds. No other Super 8 has it.

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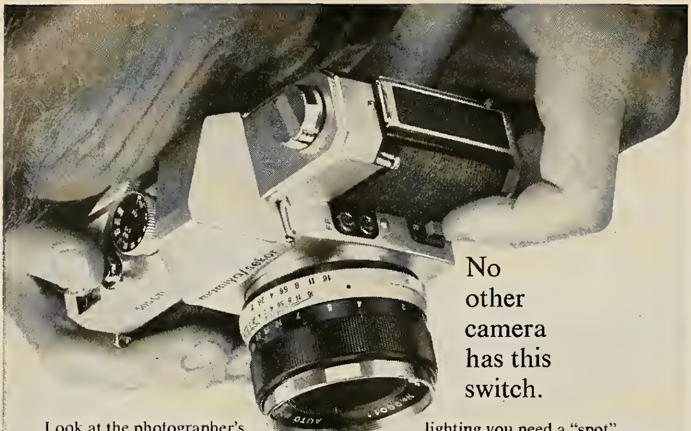

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2. We can close the wilderness t everyone. In a limited sense, this action would preserve the wildernes But it would be a wilderness lik Bishop Berkeley's "tree in the quad when no one is there: does wildernes really exist if no one experiences it Such an action would save wildernes for the future, but it would do no on any good now.

3. We can allow only limited access to the wilderness. This is th only course of action that can be rationally defended. Only a small percentage of a large population ca ever enjoy wilderness. By suitabl defining our standards, and by studying the variables in the situation, w can (in principle) work out a theor for maximizing the enjoyment o wilderness under a system of limite access. Whatever our theory, w shall have to wrestle with the problem of choice, the problem of determining what small number among vast population of people shall hav the opportunity to enjoy this scarc good, wilderness. It is this probler of choice that I wish to explore here

What I have to say applies not onl to wilderness in the sense in whic that term is understood by all goo outdoorsmen, but also to all othe kinds of outdoor recreational areas- to national parks, to ski areas, an the like. All of these can be destroye by localized overpopulation. The differ in their "carrying capacity. The carrying capacity of a Cone Island (for those who like it and there are such people) is ver high; the carrying capacity of wilderness, in the sense defined by Howard Zahniser, is very low. In th Wilderness Bill of 1964 Zahniser' felicitous definition stands for all t admire:

"A wilderness, in contrast wit those areas where man and his ow works dominate the landscape i hereby recognized as an area wher the earth and its community of lif are untrammeled by man, where ma himself is a visitor who does not remain."

The carrying capacity of Cone Island is, I suppose, something lik 100 people per acre; the carrying capacity of a wilderness is perhaps on person per square mile. But whateve the carrying capacity, as population inexorably increases, each type o recreational area sooner or late comes up against the problem of al location of this scarce resource among the more than sufficient number of claimants to it. It is at this point that the problem of limited access must be faced.

How shall we limit access? How shall we choose from among the too-abundant petitioners those few who shall be allowed in? Let's run over the various possibilities.

First: By the marketplace. We can auction off the natural resource, letting those who are richest among the sufficiently motivated buy. In our part of the world and in our time most of us unhesitatingly label this method of allotment "unfair." Perhaps it is. But don't forget that many an area of natural beauty available to us today has survived unspoiled precisely because it was preserved in an estate of the wealthy in past times. This method of allotment has at least the virtue that it preserves natural treasures until a better, or perhaps we should merely say a more acceptable, method of distribution can be devised. The privilege of wealth has in the past carried many of the beauties of nature through the first, destructive eras of nascent democracy to the more mature, later stages that were capable of appreciating and preserving them.

Second: By queues. Wilderness could be made available on a first-come, first-served basis, up to the extent of the carrying capacity. People would simply line up each day in a long queue and a few would be allowed in. It would be a fatiguing and wasteful system, but while it would be "fair," it might not be stable.

Third: By lottery. This would be eminently "fair," and it would not be terribly fatiguing or wasteful. In earlier days, the decision of a lottery was regarded as the choice of God. We cannot recapture this consoling belief (now that "God is dead"), but we are still inclined to accept the results of a lottery. Lotteries serve well for the allocation of hunting rights in some of our states where big game abounds.

Fourth: By merit. Whether one regards this as "unfair" or "fair" depends on the complexion of one's political beliefs. Whether it is fair or not, I will argue that it is the best system of allocation. Anyone who argues for a merit system of determining rights immediately raises an *argumentum ad hominem.* He im-

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mediately raises the suspicion that
is about to define merit in such a w
as to include himself in the merito
ous group.

The suspicion is justified, and l
cause it is justified it must be m
To carry conviction, he who propos
standards must show that his arg
ment is not self-serving. What I he
by propose as a criterion for adm
sion to the wilderness is great phy
cal vigor. I explicitly call your atte
tion to this significant fact: I mys
cannot pass the test I propose. I h
polio at the age of four, and g
around moderately well for mo
than 40 years, but now I requi
crutches. Until today, I have n
traded on my infirmity. But today
must, for it is an essential part of n
argument.

I am not fit for the wilderness
praise. I cannot pass the test I pr
pose. I cannot enter the area I wou
restrict. Therefore I claim that
speak with objectivity. The standa
I propose is not an example of speci
pleading in my own interest. I ca
speak loudly where abler men wou
have to be hesitant.

To restrict the wilderness to phys
cally vigorous people is inherent
sensible. What is the experience
wilderness? Surely it has two maj
components. The first is the exper
ence of being there, of (in Thoreau
words) being refreshed "by the sigh
of inexhaustible vigor, vast and t
tanic features," of seeing "that n
ture is so rife with life that myriac
can afford to be sacrificed and su
fered to prey on one another; th
tender organizations can be so s
renely squashed out of existence lik
pulp. . . ."

The experience of being there
part of the experience of wildernes
but only a part. If we were droppe
down from a line by helicopter int
the middle of this experience w
would miss an important part of th
total experience, namely the exper
ence of getting there. The exquisit
sight, sound, and smell of wildernes
is many times more powerful if it i
earned through physical achieve
ment, if it comes at the end of a lon
and fatiguing trip for which vigorou
good health is a necessity.

Practically speaking, this mean
that no one should be able to enter
wilderness by mechanical means. H
should have to walk many miles o
his own two feet, carrying all his pro
visions with him. In some cases, en

trance might be on horse or mule back, or in a canoe, or by snowshoes; but there should be no automobiles, no campers, no motorcycles, no tote-goats, no outboard motors, no airplanes. Just unmechanized man and nature—this is a necessary ingredient of the prescription for the wilderness experience.

That mechanical aids threaten wilderness is already recognized by managers of our wildernesses. Emergency roads, it is said, should be used sparingly. I submit that this cautious policy is not cautious enough. I submit that there should be *no* emergency roads, that the people who go into the wilderness should go in without radio transmitters, that they should know for certain that if an emergency arises they can get no help from the outside. If injured, they must either somehow struggle to the outside under their own power or (if lucky) catch the attention of another rare wanderer in the wilderness and get him to help. For people who are physically prepared for it, the wilderness is not terribly dangerous—but such danger as there is, is a precious part of the total experience. The knowledge that one is really on one's own is a powerful tonic. It would be cruelly sentimental to take this away from the wilderness adventurer.

There is not even a public interest in making the wilderness safe. Making great and spectacular efforts to save the life of an individual makes sense only when there is a shortage of people. I have not lately heard that there is a shortage of people.

There is, however, a public interest in making the wilderness as difficult and dangerous as it legitimately can be. There is, I think, a well-founded suspicion that our life has become, if anything, too safe for the best psychological health, particularly among the young. The ever greater extension of the boundaries of legal liability has produced a controlled and fenced-in environment in which it is almost impossible to hurt oneself —unless one tries. The behavior of the young clearly indicates that they really try. Drag races, road races, "rumbles," student sit-ins, marches, and tauntings of the police—all these activities look like the behavior of people looking for danger. I do not wish to deny that some of the activities may arise from other motivations also, e.g., idealistic political beliefs. I

Sometimes all those butterflies and buffalos move too fast in front of your camera for you to catch them inside it. Unless you've got Minolta's 35mm reflex, the SR-T 101.

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am only saying that it looks like liberate seeking of danger is part the motivation of our obstrepero young. I think it is an important pa I think we would do well to tear do some of the fences that now depri people of the possibility of danger. wilderness without rescue servic would contribute to the stability society.

There is a second way in which th interest of society is furthered by rigorous wilderness. From time time a president of the United Stat endeavors to improve the physic condition of the average citizen b resorting to a rhetorical bombar ment. The verbal ammunition co sists principally of the words "r sponsibility," "duty," and "patrio ism." These rhetorical duds no longe move the young. The negative mot vation of shame is, in general, not a effective as the positive motivation o prestige. A wilderness that can be en tered only by a few of the most physi cally fit of the population will act a an incentive to myriads more to im prove their physical condition. Th motivation will be more effective i we have (as I think we should) graded series of wilderness and park areas. Areas in which the carrying capacity is reckoned at one person per thousand acres should be the most difficult to enter: those with a capacity of one per hundred acres should be easier, those with one per ten, still easier, and so on. Yosemite Valley should, I suggest, be assigned a carrying capacity of about one per acre which might mean that it could be opened to anyone who could walk ten miles. At first, of course, the ten-mile walkers would be a very small class, but once the prestige factor took effect more and more people would be willing to walk such a distance. Then the standard should be made more rigorous.

I am sure other details of such a system would eventually have to be faced and worked out. It might be necessary to combine it with a lottery. Or some independent, easily administered test of physical fitness might be instituted. These are details, and in principle can be solved, so I will not spend time on them. But whatever the details, it is clear that many of our present national parks and national forests and other recreation areas should be forever closed to people on crutches, to small chil-

. to fat people, to people with t conditions, and to old people in ısual state of physical disrepair. the basis of their lack of merit, people (and remember, I am a ıber of this deprived group) ıld give up all claim of right to wilderness experience.

he poet Goethe once said, "We t earn again for ourselves what ıave inherited," recognizing that those things that are earned can precious. To be precious the heri- of wilderness must be open only hose who can earn it again for nselves. The rest, since they can- gain the genuine treasure by their efforts, must relinquish the dow of it.

Ve need not be so righteous as to y the excluded ones all experience he out-of-doors. There is no rea- in the world why we cannot ex- d our present practice of setting small outdoor areas where we mit a high density of people to get ny whiff of nature. Camping cheek jowl with thousands of others in outdoor slum does not appeal to personally—I have not visited semite Valley in thirty years—but re are people who simply love this mmy togetherness, a fact that Sier- Clubbers sometimes forget or find rd to believe. By all means, let us ate some al fresco slums for the ople, but not in the likes of Yose- te Valley, which is too good for s purpose. But there will be little s if some of the less attractive for- areas are turned into outdoor ms to relieve the pressure on the lly good areas. We must have es that fairly pullulate with water iers in order that we may be able set aside other lakes for quiet ca- eing. We must have easily reached aches that fairly writhe with oily dies and vibrate to a steady ca- phony of transistor radios, in order keep up other beaches, difficult of cess, on which we can forbid all ise makers.

The idea of wilderness is a difficult ıe, but it is precisely because it is fficult that clarifying it is valuable. discovering how to justify a re- ricted good to a nation of 200 mil- on people that is still growing, we nd a formula that extends beyond ilderness to a whole spectrum of creational activities in the national mmons. The solution of the difficult ıse erects a framework into which her cases can be easily fitted.

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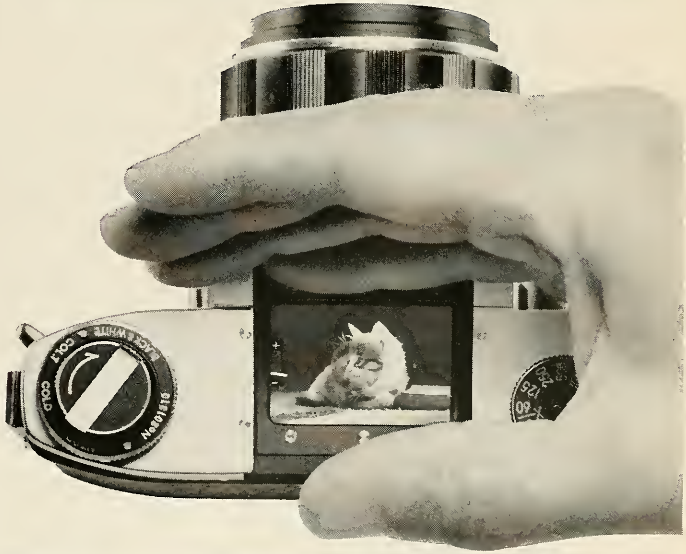

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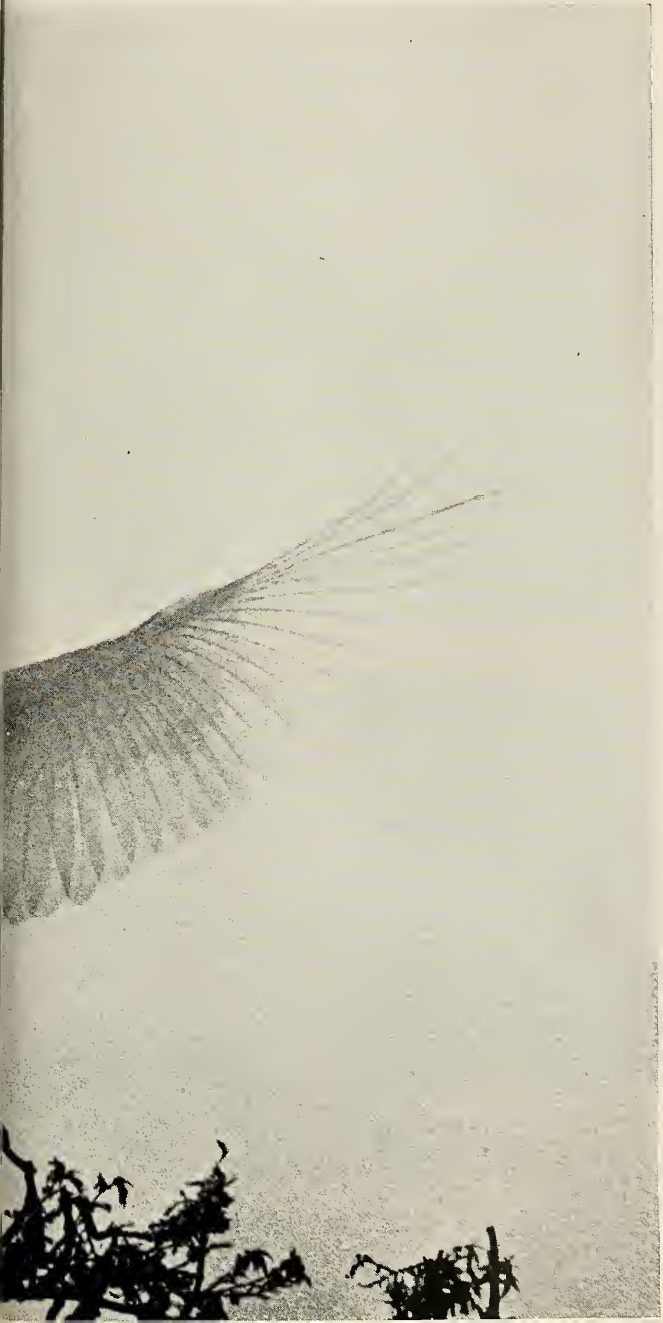


Nature and the Camera

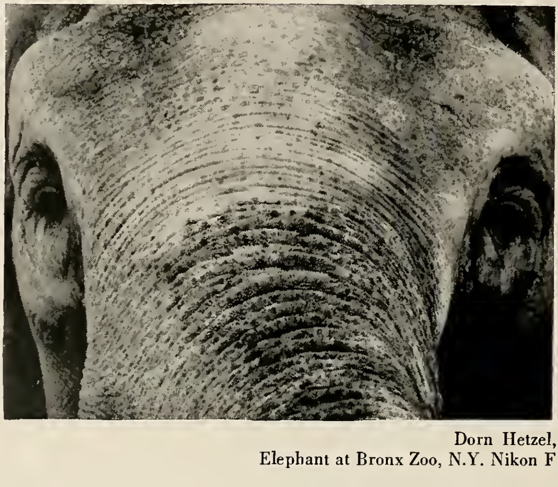
A gallery of selected prizewinners in Natural History's second Photographic Competition appears on these pages. A complete list of winners, chosen from nearly 3,000 entries sent in from the United States and abroad, may be found on page 82 Judges for the contest were Jacob Deschin, Photography Editor, *The New York Times*; Andreas Feininger, photographer; Peter Braal, Chief of Photographic Illustrations, Eastman Kodak Company Arthur Rothstein, Director of Photography, *Look*; and Thomas Page, Art Editor, Natural History.

First Prize Black and White

Herbert W. Pohle,
Common Egret at nesting time, Wisconsin. Nikon F

Alma Hochhauser, Traveler's Tree at
Brooklyn Botanic Garden, N.Y. Rolleiflex

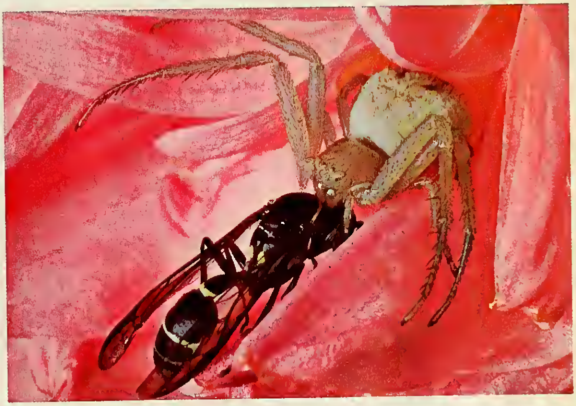
Keith Axe
Zebras in Nairobi National Park, Kenya. Pentax



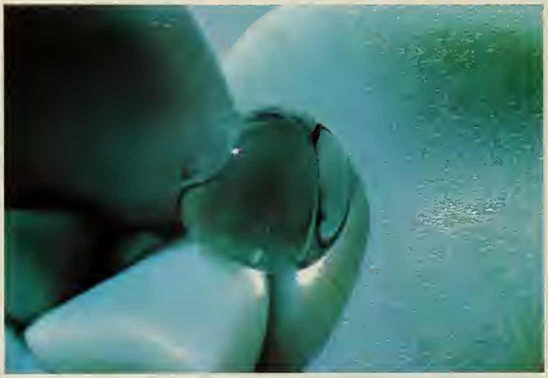
Dorn Hetzel,
Elephant at Bronx Zoo, N.Y. Nikon F

Elmer E. Nielson,
Cathedral Mountain in Yoho National Park, B.C., Canada. Pentax H-3

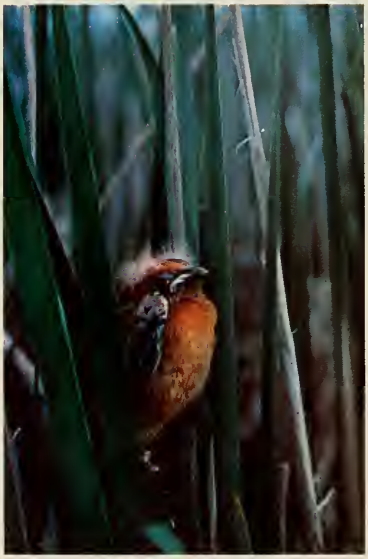
Mrs. Howard Crew,
Flamingo Colony, Mexico. Rolleiflex



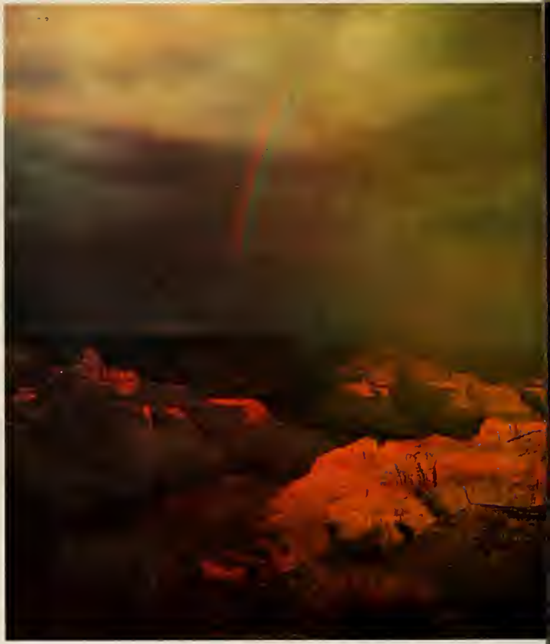
James H. Carmichael, Jr.,
Spider eating wasp, Mexico. Leica IIIR



Tracy M. Kramer, Jr.,
Water drop in flower rosette, Florida. Topcon C



Eleanor Earle Rolf,
Yellow-headed Blackbird
fledgling, Minnesota. Miranda F



Wolfgang Ma
Storm in Grand Canyon, Arizona. Rollei

First Prize Color

Syd Radinovsky,
Snow on twigs, Kansas. Exacta

Grand Prize

Wilbur S. Tripp,
Great Horned Owls, Canada. Hasselblad 500C

Frog effigy by contemporary Mohave

Freehand lines typify Acoma bowl

Dull-finished Santo Domingo bowl

Polished red matte—San Ildefonso

San Felipe bowl—handle is uncommon

Native Pottery of the Southwest

In pueblos and other centers, the practical and beautiful craftsmanship of their ancestors is being kept alive by American Indian women

by George L. Downing

The Mohaves were suffering from the dreadful cold and had no way to make fire. The enemy was pressing them from three sides, and the river behind them barred their escape in the other direction. The Mohaves were near death.

Suddenly, on the darkness of the water behind them, a light appeared, then another, and another. The frogs were coming from across the water. In their mouths they were bringing firebrands. Now were the Mohaves saved from freezing, and they went on to overcome their enemy.

Today, partly because of that folktale, the frog effigy is one of the more sought-after pieces of pottery made by the Indians of the American Southwest. Beautiful in a rugged fashion, this product is the work of the sole surviving Mohave potter, Annie Fields. Over 90 now, she has produced no work for some time. Not only her frog effigies but her human effigies, adorned with real hair, and her ladles soon will be unobtainable, if they are not already so.

These are only a few of the representative pieces of pottery made nowadays by the Indians of the southwestern United States. Some are classic works of art; others are, understandably, of poor quality and sold in curio shops across the breadth of the land. However, all merit attention by the serious devotee of Indian art, for they are handcrafted, a skill that seems to be slowly disappearing.

The pottery varies considerably in size. Some effigies are no more than two to three inches long; some modeled owls of the Zuñi stand no higher than two to three inches. Larger vessels may be a foot or more high and have a comparable diameter. Since almost all pottery sold goes to collectors or people who want it for a certain decor in their homes, small pieces—ranging from four to eight inches in diameter and height—are the most common.

Prices today depend on many factors and are as variable as the sizes and kinds. Average-sized ware, from four to eight inches in diameter and height, ranges in price from $5 to $75. On rare occasions, the buyer may find well-made pottery signed by good potters at a cost of no more than $5 or $10.

The early origins of this craft go back hundreds of years. Even those lesser pots, bowls, and other articles that might be eschewed by present-day Indian buffs stem from a people who at one time made quality pottery—pottery that was meant to participate in the everyday lives of the makers. Some pieces were made for ceremonial purposes, but most were utilitarian.

The accompanying map shows twenty-one centers where these potters can still be found. (Sandia, Nambe and Guadaloupe Indian Village produce no pottery.) All of the potters are women. Only rarely does one find a male potter, although men will sometimes decorate the pots.

North of Santa Fe, New Mexico, lie six reservations and five pueblos. Here the Tewa-language group lives in the pueblos of Santa Clara, San Juan, San Ildefonso, Tesuque, and Nambe. Some of the best-known potters reside at Santa Clara, San Juan, and San Ildefonso. It is in these three pueblos, perhaps, that modern pottery technique among southwestern Indians has reached its peak. They are famous for polished (burnished) and incised wares. Of these, their polished wares are better known to collectors and traders. The potters obtain a high polish by rubbing the fired piece with soft leather or a smooth stone until they achieve a beautifully smooth and glistening surface. This ware is available in both red and black.

The difference in color results, not from a difference in pigments added to the clay, but from the way the pot is fired. The red ware—actually more of a brick red—is fired in an atmosphere where oxygen is readily available; and the fire itself, fueled with dry dung, is allowed to burn cleanly. In contrast, for black ware the fire is smothered with fuel near the end of

Picuri bean pot with cover

the process. This results in a reducing atmosphere that will produce a sufficient quantity of carbon to blacken the piece.

A revival that has brought fame to black-on-black pottery accounts for some of the most beautiful specimens of the potter's art available today. Here, the potter combines a dull-finish, or matte, black with the polished black. The result is highly prized by buyers when well done. And it is elegantly done by several potters at San Ildefonso.

Quality black ware, regardless of the pueblo from which it originates, has no other color associated with it. The various designs may be pressed into the piece, cut into it, or shown by black matte.

There is also a matte tan on polished red, which is produced by at least two potters at San Ildefonso. At Santa Clara, the potters produce equally fine polished black and red ware but no matte ware of the kind that comes from San Ildefonso.

The matte design became popular in the early 1920's, but is associated today only with the pueblos of Santa Clara and San Ildefonso. Mammal and bird effigies are also common in Santa Clara wares. The bear-paw design in polished black is unique to Santa Clara.

Recently, a family team from Santa Clara began to produce ware that may be the start of a trend in pottery making among the pueblos. Theirs is a well-decorated product, with the design done in commercial paints. It usually depicts stylized animals of one sort or another in association with carefully executed geometric designs. They also produce small effigies of mammals and other animals. Their work has become popular, but since they do not work consistently, their output is sporadic.

Incised ware, a revival of a pottery type that had its origins in the fifteenth and sixteenth centuries, is associated exclusively with another of the pueblos, San Juan. Here, before firing, the potter cuts geometric patterns of parallel lines into the piece, then applies a thin, watery clay solution, or a slip, over the incised area. Firing follows. The slip evens the surface so it can be polished later if desired. This is a common practice in pottery making. In the case of the San Juan incised ware, the slip contains mica, which gives it a characteristic appearance. The resulting pots have an unpolished design of tan, while the rim and base are generally polished red.

A beautiful polychrome pottery is also produced at Santa Clara. Designs in natural ocher, gray, and orange pigments are delineated in white on a polished red base.

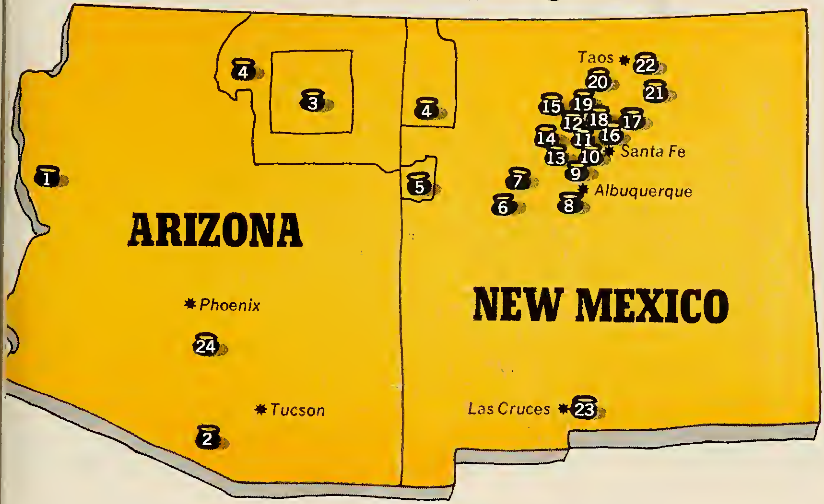
Only rarely is pottery of any kind produced at Tesuque. The greatest portion of the ware made there is sun dried and consists of small bowls and effigies representing rain gods. These are garishly decorated with poster paint and are obviously designed for the tourist trade. On the other hand, it is regrettable that no pottery is now produced at the pueblo of Nambe. This pueblo boasted a fine quality ware at one time.

Fifty miles west of Santa Fe are the Jemez Indians, the only group still speaking the Towa language. They have followed the lead of the inhabitants of Tesuque in their pottery making. Bean and chili pots are produced, but not for marketing. The rest of production here is confined to the sun-dried, poster-painted pottery made for the buyer who wants only "an Indian souvenir."

Micaceous ware characterizes the work of the Picuris and Taos of the Northern Tiwa group. Their pottery has no painted design, yet is easily recognized because it shows minute flecks of mica. The over-all color varies from brown through tan to a bright orange, and commonly has black smudges called "fire clouds." These come from the firing, are typical of this pottery, and in no way indicate inferior quality.

A wide-mouthed pot made by the Picuris is considered the ultimate for cooking chili or beans. Such pots are

Southwestern Pottery Region



1. Mohave
2. Papago
3. Hopi
4. Navaho
5. Zuñi
6. Acoma
7. Laguna
8. Isleta
9. Sandia
10. Santa Ana
11. San Felipe
12. Santo Domingo
13. Zia
14. Jemez
15. Cochiti
16. Tesuque
17. Nambe
18. San Ildefonso
19. Santa Clara
20. San Juan
21. San Lorenzo (Picuris)
22. Taos
23. Guadaloupe Indian Village
24. Maricopa

widely used by Indians and non-Indians alike in the Southwest for preparing these two foods.

The pueblos of the Eastern Keres language group— Cochiti, Santo Domingo, San Felipe, Zia, and Santa Ana—produce pottery that is mostly black on white. The major producers use essentially the same style in their vessel-type pots.

The bottom of the pot is left red, and this red usually extends one or two inches upward on the sides, depending on the vessel's size. Two black lines separate the red on the lower part of the vessel from the white background that extends to the top and sometimes inside. At the top, two parallel lines circle the opening. These are also black, and usually a break appears in the lines. Its purpose is to release the "spirit" of the pot. The lines are applied with heavy black paint. In Santo Domingo, work is usually applied in curvilinear and rectilinear geometric designs.

At Cochiti the pot design is more erratic than that of Santo Domingo, and at times, its components are totally unrelated to each other. Human as well as animal figurines are produced in quantity and are a popular product of this pueblo. The Cochiteños incorporate ceremonial symbols in some of their nonceremonial wares, but such symbols are not used at the other pueblos when the pottery has no ceremonial purpose.

San Felipe boasts one potter, a woman who recently revived the art there. She works rather sporadically, however, and does not produce much. Her pot has a heavy wall and base, sometimes as much as a half inch thick. The basic pattern and color, though less elaborate, duplicate those of Santo Domingo and Cochiti.

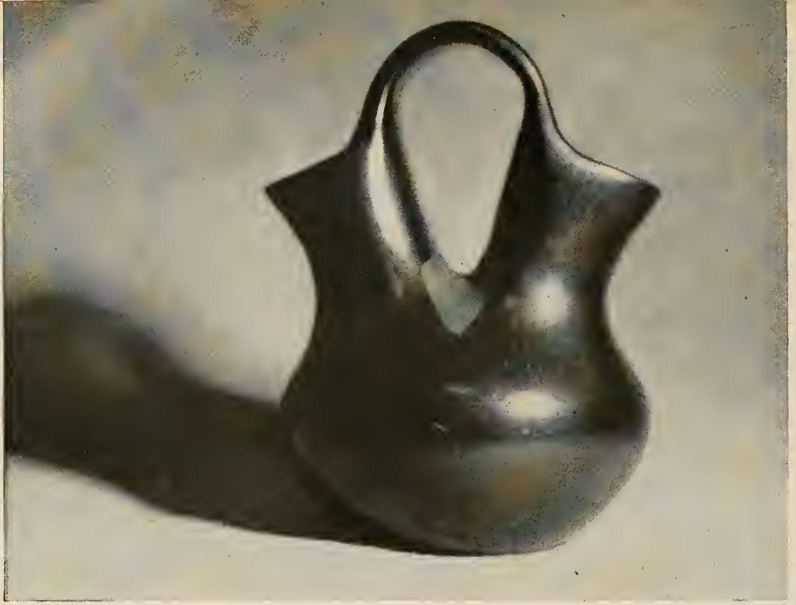
In Santa Ana, although one potter survives, production has all but ceased. But the predominantly polychrome products of the Zia Pueblo are generally considered the finest made by any of the Eastern Keres. These wares are most commonly decorated with stylized bird and flower designs incorporating both curvilinear and rectilinear patterns. The spirit lines of other Eastern Keres pueblos are missing on almost all Zia work.

This pottery is so well fired that it can be used for water storage, and larger jars are made for this purpose. The highly decorative aspect of Zia ware also attracts collectors who want them for flower vases.

The Western Keres language group has two pueblos, Acoma and Laguna. Acoma Pueblo, which has existed for approximately 600 years, is a "city in the sky" that boasts several potters of great skill. As at Zia, their well-fired work will hold water; also, it rings prettily when tapped lightly with a knuckle. The better wares are exquisitely painted. Here, black on white is the favorite.

When looking at these Acoma products it is difficult for one to understand how such meticulous work could be done by hand. A favorite design incorporates many parallel black lines, no more than one-sixteenth inch apart, into a variety of pleasing geometric patterns. Acoma also produces a good quality tan ware decorated with black. One of its outstanding potters turns out pots carrying the symbolical image of a deer—the arrow entering its mouth is also seen piercing its heart. A similar deer image is common on older Zuñi pots.

Laguna Pueblo, the largest on the eastern side of the Continental Divide, is the only extant pueblo remaining of those founded after Spanish colonization. Almost no pottery is produced here today. The ware still available, and the rare pieces still produced, closely resemble earlier Acoma pottery in design, but they are heavier walled and not so well decorated. The base is invariably brown for one to two inches upward. The rest of the lower part is red and sometimes decorated with curvilinear and rectilinear designs. The upper portion is white with a design executed in brown, black, and red.



Double-necked wedding jug— San Ildefonso

Also in New Mexico is the Southern Tiwa language group, comprising Sandia and Isleta pueblos, both near Albuquerque, and Guadaloupe Indian Village, in Las Cruces. Of these, only in Isleta is pottery made today, and production in any quantity was not revived until recently. Considered *in toto* the Isleta ware is of poor quality and sloppily decorated, although occasionally a good, carefully done piece will appear.

Isleta pottery is thin-walled; the background is always white. A black design, applied after firing, is usually painted on along with one or more bright poster paints. A careful potter can make these rectilinear and curvilinear designs both intricate and pleasing, but the nature of the design has no apparent significance. It is, rather, a creation of the potter herself and sometimes appears to incorporate certain aspects of other pueblo pottery designs that she may have found attractive.

The Zuñian language group occupies the Zuñi Pueblo south of Gallup, New Mexico. The Zuñis excel at handicrafts but their pottery is a distant second to their famous jewelry. The pueblo once produced pottery of good quality. Zuñi potters emphasized design rather than form, however, and their ware often showed an irregularity of surface that one rarely finds in contemporary work. Today's most popular product is the modeled owl, which has been made for years and is unique to Zuñi Pueblo. A dull-white slip forms the base color. Curved lines of either black or dark brown are painted on to represent feathers. Greater detail is found on the head, and brick-red paint accents the eyes and beak. Such owls are made in sizes up to a foot or more.

Next to New Mexico, in Arizona, the Hopis occupy three mesas east of Grand Canyon National Park. Their pottery, in the traditional design reminiscent of the Sikyatki ware made five centuries ago, is the most easily recognized of all Indian pottery. All of the decorated Hopi ware is produced on the First Mesa. The village of Hotevilla produces an undecorated ware, much of it used in cooking.

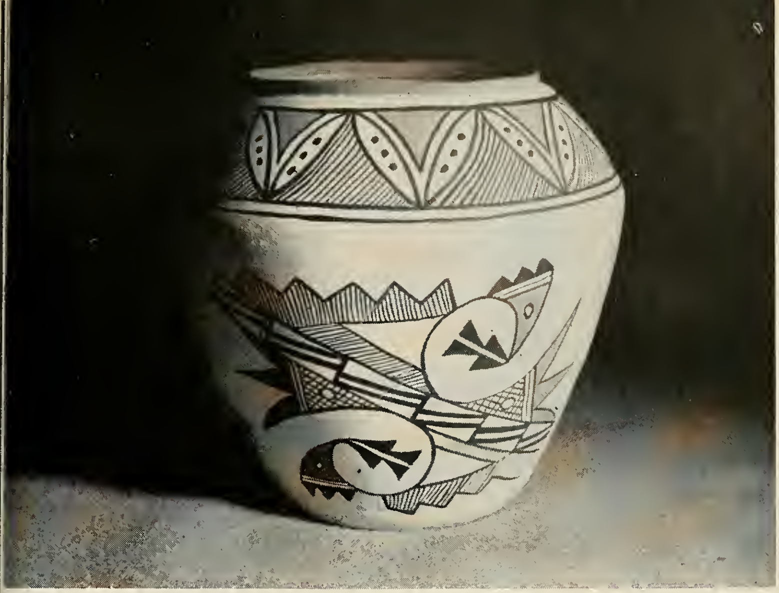
The most recognizable design in Hopi pottery was revived at the turn of the century by Nampeyo, at Hano, a village of the First Mesa. Her husband had been a laborer for archeologists who were excavating ruins on the Hopi reservation. The designs on shards that he had shown her later served as the models for the designs on her famous ware.

The background color of Hopi ware is almost invariably white or yellow, with an occasional orange cast. The designs, in black and red, once were applied with cloth or a rabbit's tail. The artisan is more likely now to use a standard artist's brush. There are a number of good Hopi potters, whose intricately decorated ware, made in almost every conceivable shape, is the most elaborate of all in the Southwest.

The making of pottery is not confined to the Pueblo Indians. As the art forms of the pueblos dispersed southward and westward, pottery making became a part of the art crafts of the entire group of inhabitants of the Southwest, pueblo and nonpueblo.

For example, among the pottery makers of some renown are the nonpueblo Maricopas. Fleeing oppression by the Yumas in the nineteenth century, the Maricopas left their Colorado River homeland to live with the Pimas. Although the two groups speak different languages, they follow nearly identical ways of life. This is reflected in the pottery made by both groups.

A highly polished red slip is typical of Maricopa pottery, which is obtainable in either the decorated or undecorated form. In rare instances it will have a tan or off-white band, varying in width from one to two inches, at the rim of the open-mouthed pieces. A curvilinear design seems to be preferred for the decorated pots. On occasion this design will be applied in such fashion as to form a triangular pattern. Whatever



From Isleta, a quality-grade modified bowl

e design, however, it is usually apied carelessly.

Of all ware produced by Maricopa tters, the long-necked jug is perps the most dramatic. It is found in th decorated and undecorated rms. While the latter condition s been the preferred one, there now pears to be a trend toward designs.

The Papago Indians of Arizona oduce a pottery resembling that of e Maricopas, but thicker-walled. It s a highly burnished red or white ckground. Sometimes pixylike ces appear in the decoration below e rims of the bowls. As with Maripa pottery, when a design is apied it is done carelessly.

The only other nonpueblo pottery be found today is Navaho. Pitch om the piñon pine is used to give e "pitching," inside and out, that pifies this ware. The pottery usuly is rounded on the bottom, so it es not set well unless stabilized ith a pot ring made of plaited yucca aves. Navaho ware is made for use. he typically rounded base is innded for easy balance when placed rectly in the cooking fire. This potry is left without a design except for llets of clay that are "roped" beath the rim. The ware, characrized by a mingled brown-black lor, has a charm of its own.

Recent innovations in Navaho ork reflect the demand by buyers, both private and commercial. Some kilned work is now being produced. It has a definitely smooth, dung-colored background and is decorated with a black design in a rectilinear pattern. The over-all product has the appearance of the stoneware used so widely in American homes today.

As we move through the years from America's beginnings as a nation we apparently want to hold to some of its pre-Colonial aspects. This may explain, in part, why we are experiencing an ascendant interest in Indian craft arts.

These arts established themselves along the Rio Grande in New Mexico after being driven from their original homelands farther north by marauding enemies, and they have added much to American art. The nonpueblo tribes, particularly those in Arizona, deserve special credit for doing much to keep native crafts extant.

Both groups, pueblo and nonpueblo, have modified their work and styles from time to time. Improved tools led to better jewelry. Aniline dyes made more highly colored rugs possible. In some areas today, even commercial kilns are being used in pottery making. All these innovations are held by some to be a natural evolution of the arts involved. Perhaps it is. But the charm of pottery produced in the kiln fired by manure or bark is lost in the hard glaze of the commercially kilned work.

Furthermore, and understandably, almost all pottery produced today is for sale to collectors. In other words, much of it—whether bought at an Indian reservation or gift shop—is nonutilitarian. Its esthetic value, of course, is based upon personal preference.

Meanwhile, southwestern Indian pottery bought today at reasonable prices could well double or triple in value in a matter of two or three years, one reason being that it is a vanishing art. Increasingly, educational opportunities attract the younger Indians to other forms of livelihood. Also, the jobs available make the exacting art of pottery making impractical in terms of its monetary return, and so the small number of truly fine potters is dwindling.

Also, and not so surprising as it may seem at first, demand for a handmade product sometimes brings about a deterioration of quality. This appears to be the case with the sundried wares and certain others desired by the affluent American vacationist with an avid urge for acquiring souvenirs. Perhaps the demand for quality takes a back seat when this urge manifests itself. After all, the buyer can always assure himself that even the poor-quality product is truly "Indian-made."

SKY REPORTER

FIREBALL OVER MEXICO If you're in the business, the only thing better than finding a meteorite is finding a fresh meteorite. A sort of restrained pandemonium broke out last February when a fireball blew up over Mexico, and the experts found themselves with several hundred pounds of fresh pieces and even samples of the dust and smoke left behind in the atmosphere.

Hundreds of Mexicans in the Pueblito de Allende area reported a flash of light in the sky followed by an explosion. Word quickly reached the Smithsonian Astrophysical Center for Short-Lived Phenomena, Cambridge, Massachusetts. They in turn called the Air Force, and soon a B-57 carrying special filter traps flew through the train of dust left by the meteor. These samples were then flown to the U.S. Geological Survey laboratory in Menlo Park, California.

Ground efforts were not far behind. A scientist at the Manned Spacecraft Center in Houston crossed the border and began the search for fragments. He called the center to report he had found 20 samples weighing a total of more than 200 pounds. Some of these went to NASA laboratories; others went to the Smithsonian Astrophysical Observatory, where radioisotope measurements began less than 100 hours after the explosion.

Two Smithsonian teams sped to the scene. One searched for (and found) additional fragments; one gathered eyewitness reports to help plot the meteor's trajectory and even its possible origin in the solar system.

NOW FORMALDEHYDE The most complicated molecule yet—and one with important implications for the origin of life—has been found in interstellar space. One atom each of carbon and oxygen and two of hydrogen make up the molecule of formaldehyde, a common disinfectant and preservative.

A team of astrophysicists working with the 140-foot radio telescope at Green Bank, West Virginia, made the discovery. They reported in *Physical Review Letters* that a line characteristic of formaldehyde turned up in 15 of 23 radio sources they surveyed.

Discovery of formaldehyde follows by only months the first detection of ammonia and water in space. Scientists are excited not only because they are finding complex molecules but because they are finding the chemical constituents of the organic molecules necessary for life to begin. They have long believed that stars and their planets condense out of the clouds of hydrogen and dust that swirl between existing stars. If these clouds include water, ammonia, and formaldehyde, it becomes much easier to explain the beginning of life.

Nearly 20 years ago Stanley Miller succeeded in producing amino acids—basic building blocks of life—in an atmosphere of methane, ammonia, hydrogen, and water. (Methane has not been detected in interstellar space, but formaldehyde is considered strong evidence of its presence.) The problem had been to explain how these compounds got into the planet's primitive atmosphere.

Much remains to be done. Water and formaldehyde have been found in the same interstellar gas clouds, but so far ammonia has not been found along with them One ammonia source near the galactic center may be th same as a formaldehyde source. The trick now is to fin all three in the same place.

SUPERNOVA CLUES Pulsar hunters are g ing back to Chinese records 1,000 to 2,000 years old t test the theory that pulsars are neutron stars left as th remnants of supernova explosions. They want to chec one more time the locations where Chinese astronomer reported the sudden appearance of very bright stars.

C. S. Shen of Purdue, writing in the British journa *Nature*, suggests five promising candidates. The dis covery of a pulsar (and presumably the neutron sta responsible for the pulses) in the Crab Nebula alread has triggered a second look at other known supernova remnants; the Crab is almost certainly the remains o the explosion of a star in 1054. Shen proposes that hi five locations also be examined, even though supernova remnants have never been found there.

Objects at these locations were very bright when the were seen. Chinese records compare the brightness o an object seen in 1006 to a quarter moon, but no optica remnant or radio source has been found at the site o that explosion.

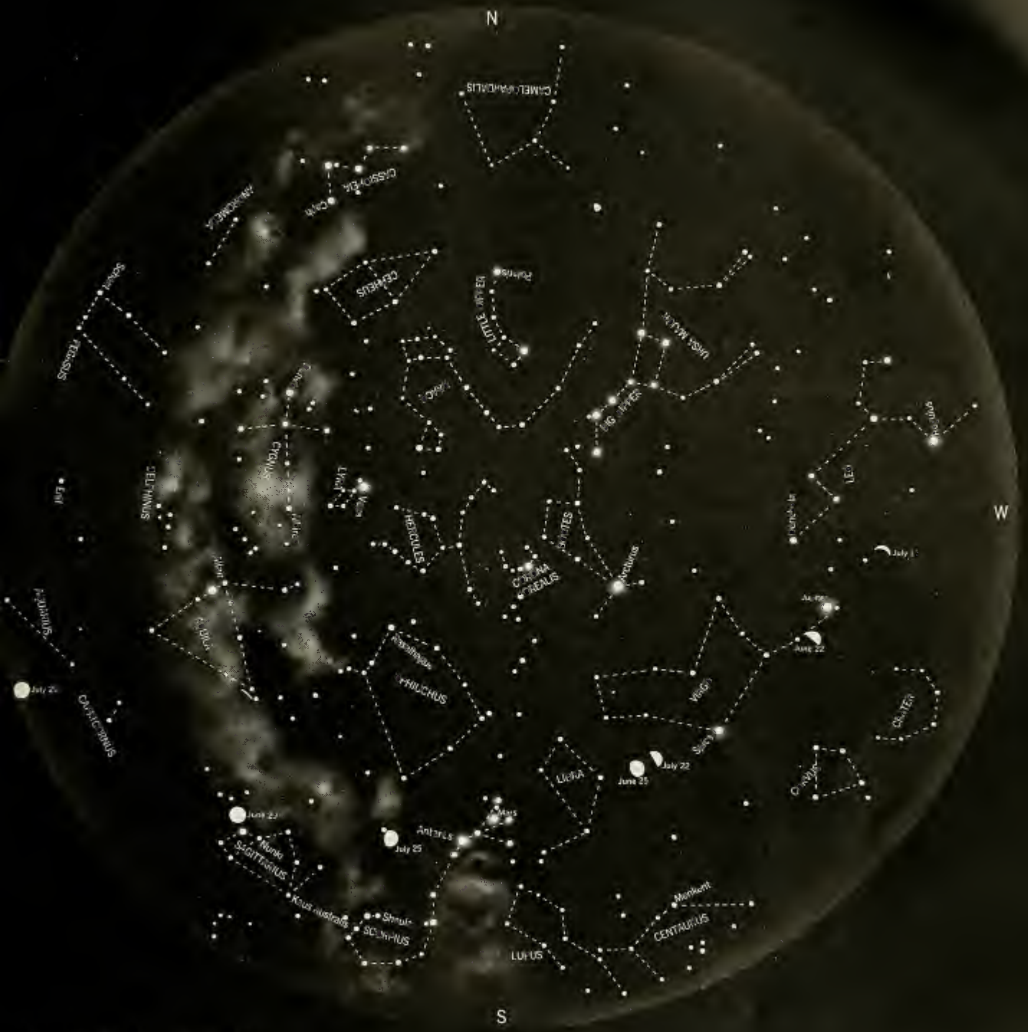
Shen points out, however, that in this case, as wit the other four candidates, the explosion occurred at galactic latitude where weaker magnetic fields and les pressure from interstellar matter may have produce different results than with the 1054 event. The five wer so bright that Shen suspects they were relatively close They must have been, to have been recorded as "big a a peach," "discovered during daylight," "brighter tha Venus," and "size of an orange."

NEIGHBORHOOD CENSUS Peter van d Kamp of Swarthmore College, famed for his painstakin studies of minute stellar motions, has revised his 195 list of stars within 17 light-years of the sun. His stella census, reported in the *Publications of the Astronomica Society of the Pacific*, shows a gain of two, for a total o 59 separate stars (including the sun, excluding seve real, but unseen, companions).

The local population may be typical of that of th entire Galaxy and therefore is of some interest. The su is the fifth brightest of the 59 stars. At the other end o the scale, two stars are only 1/50,000 as bright as th sun. About half the stars move through space by them selves; of the rest, however, 22 are locked in 11 binar systems, and 6 are intertwined in two triple systems. Si are white dwarfs; most of the rest are either red dwarf or subdwarfs.

The unseen companions range in mass from a quarte that of the sun down to only 1.6 times that of Jupiter Van de Kamp has no doubts about their reality: "An uneasiness about accepting the reality of these is alle viated by the historic fact that at one time the fain visible companions Sirius B, Procyon B, and Ross 614 were unseen companions."

JOHN P. WILEY, JR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CAMELOPARDALIS
CASSIOPEIA
Caph
ANDROMEDA
PEGASUS
Scheat
CEPHEUS
Polaris
LITTLE DIPPER
URSA MAJOR
BIG DIPPER
DRACO
CYGNUS
Deneb
DELPHINUS
Enif
LYRA
Vega
HERCULES
BOOTES
CORONA BOREALIS
Arcturus
LEO
Regulus
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July 19
June 22
AQUARIUS
July 29
CAPRICORNUS
AQUILA
Altair
Rasalhague
OPHIUCHUS
VIRGO
Spica
CRATER
CORVUS
LIBRA
June 25
July 22
June 27
Nunki
SAGITTARIUS
Kaus australis
Antares
July 25
Mars
Shaula
SCORPIUS
LUPUS
Menkent
CENTAURUS
S

CELESTIAL EVENTS

In June, the last-quarter moon occurs on the 6th, new moon on the 14th, first-quarter on the 22nd, and full moon on the 29th. In July, the moon is at last-quarter on the 6th, and new moon occurs on the 14th, first-quarter on the 22nd, and full moon on the 29th.

Jupiter and Mars are evening stars in June and July: Jupiter in the southwest at dusk, setting in the late evenings; Mars rising in the east after sundown and remaining visible till dawn. Venus and Saturn are morning stars. Venus is the brighter, appearing in the east at dawn. Saturn is below Venus until June 11; thereafter it is higher and to the right of Venus.

June 17: Venus reaches greatest elongation (west) in the morning sky.

June 21: The sun arrives at the summer solstice at 8:55 A.M., EST; summer begins in the Northern Hemisphere.

June 22: The planet near the moon is Jupiter.

June 26-27: The two reddish objects near the moon are Mars and Antares. Mars is the higher of the two.

June 29: Perigee spring tides today will produce unusually high tides.

July 5: Earth is at aphelion, farthest from the sun, 94,510,000 miles away.

July 8-10: The moon is near Saturn in the morning sky of the 8th, near Venus by the 10th, and between the two on the 9th.

July 19-20: The planet near the moon is Jupiter.

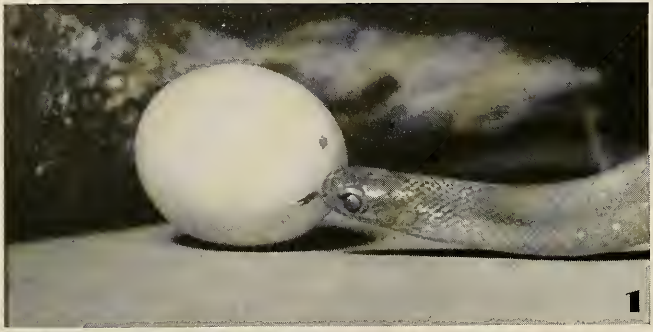
July 22: Mercury is in superior conjunction and enters the evening sky.

July 24: Mars is near the crescent moon early in the evening; Antares is nearest the moon by morning.

THOMAS D. NICHOLSON

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 11:20 P.M. on June 1; 9:25 P.M. on July 1; and 7:25 P.M. on July 31; but it may be used for about an hour before and after those times.

(GULP!)



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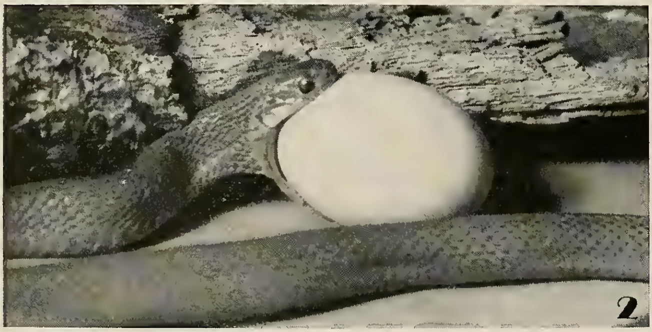

2

The prize is a meal that will suffice *Dasypeltis scabra* during several weeks of lazy living. The meal is a full-size egg, stolen from a bird's nest or from a chicken coop. The challenge facing the thieving African egg-eating snake is to swallow that egg whole. For the egg is three or four times the neck diameter of the relatively small reptile, which is hardly ever more than three feet long and about three-quarters of an inch in diameter.

This harmless egg-eater is unusual not only for its ability to swallow and retain, for a while, such a large object in its mouth and gullet but also because evolution has provided it with an uncommon crushing mechanism. This is a row of bony projections, pointing downward from the vertebrae into the gullet, that enables the snake to fracture the egg, after which muscular processes crush the shell and, in effect, squeeze the egg's nutritious liquid portion into the stomach. Afterward, the snake expels the mass of mashed shell through its mouth. The egg must be intact before the sequence of feeding operations begins, and it remains intact until broken in the gullet; the reptile's few small teeth do not puncture it.

The entire operation takes from thirty to forty-five minutes. This includes a thorough investigation—"tongue-feeling"—of the egg to make certain that it is fresh and digestible. The snake will reject a partly incubated or otherwise objectionable egg. For instance, the reptile shown here ignored a boiled one offered by the photographer.

The species, an excellent tree climber and nocturnal marauder, ranges in color from olive to light brown. It can be found throughout Africa, but occurs most abundantly in savannas.

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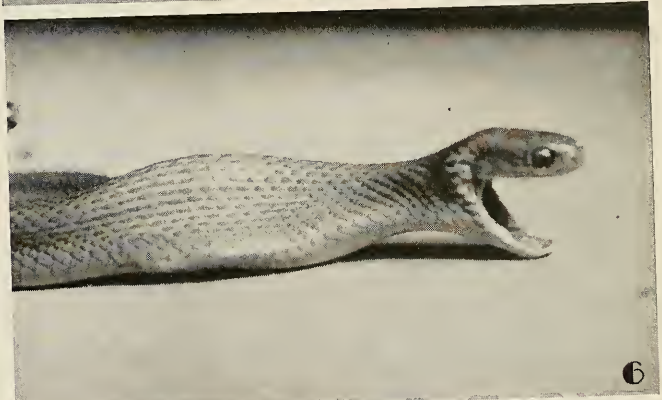

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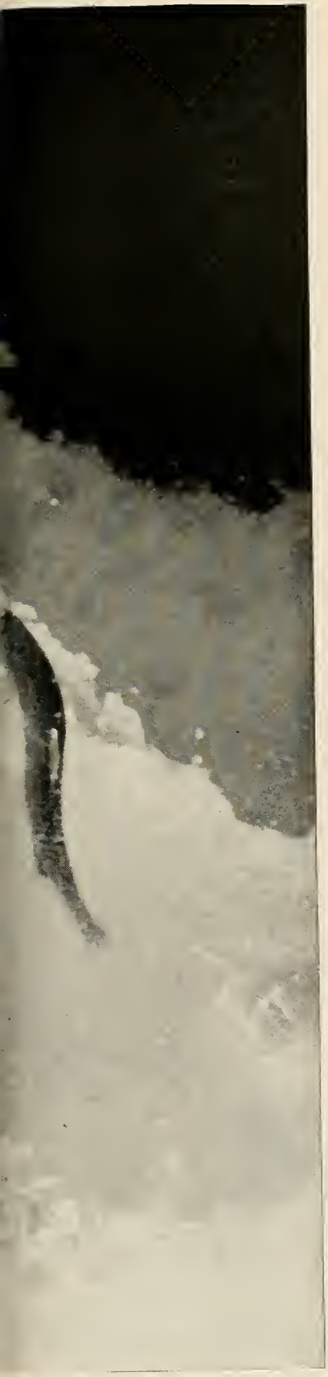
PHOTOGRAPHS BY KURT SEVERIN



Round Trip with the Salmon

The migratory drama begins when fingerlings by the millions find their way from the rivers of North America and Siberia to the saltwater pastures of the North Pacific. It ends with the return of grown salmon to natal waters, there to mate and die

by Anthony Netboy

Each year from spring into summer there is an enormous stirring in headwaters of the great salmon rivers that feed into northern seas. The new crop of young, alerted by the rushing waters of spring spates, are now on the seaward stage of their life cycle. This massive migration of fingerlings—as the smolts are commonly called along the Pacific coast—is generally invisible to spectators ashore because the small fish usually travel at night.

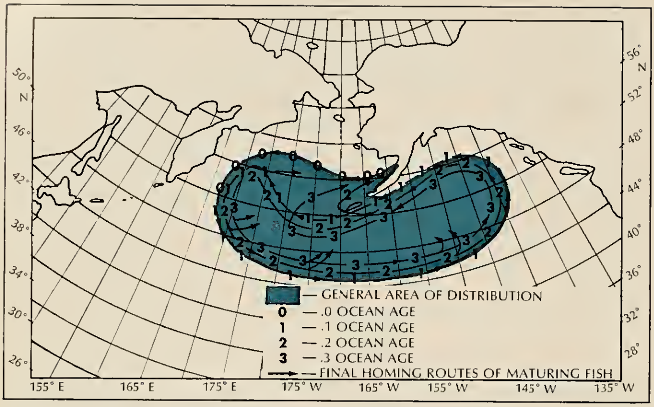
Some rivers in British Columbia, Alaska, and Siberia may each send 30 to 40 million fingerlings toward the sea every year. But there are also many hazards, and as a rule, mortality is heavy.

In the Columbia River system, for example, fingerlings moving downstream from the upper waters in Idaho, eastern Oregon, and Washington must run the gauntlet of foaming waterfalls and cascades, and also evade the irrigation ditches that could lead them to their death. Since the Columbia River now has many power dams between 70 and 100 feet high, the little fish must be able to find the intakes and pass through the swiftly revolving turbines in the power stations or else dash up and over the spillways. Many of them die; many emerge in a dazed condition and are easy victims of predators. Some rivers may also present other obstacles such as a moving wall of undissolved sewage or the foul, floating masses of refuse from pulp mills and chemical plants. On certain Canadian, northern European, and Siberian waterways the travelers must contend with pollution created by log rafts or the poisonous sludge dumped by gasoline-driven barges.

In contrast, on undammed Fraser River in Canada the fingerlings' passage is relatively swift and easy. There is little to indicate the existence of man: sometimes it is the faint smell and taste of wood from an occasional mill operation; or it may be a pipeline or bridge casting its shadow over the clear waters of the upper tributaries or farther downstream. Few actual settlements of humans are passed until the young salmon reach the region of the river's densely inhabited delta.

Entering the estuary, they find themselves in a rather different environment because of tidal effects. Here they swim back and forth for quite some time, in this way gradually becoming acclimated to the water's increased salinity. While confined to this intermediate zone between river water and ocean water they may be decimated by predators, especially birds—gulls, terns, and so forth.

If the salmon does disappear safely into the sea, it enters another stage of what to man is part of the mystery. The earliest records suggest that wherever salmon are found they have not only been valued as a savory food but have also fascinated man with their peculiar life cycle, of which some details were already dimly perceived in the Paleolithic age 15,000 years ago. Most intriguing, of course, is the puzzle of how, when the grown salmon returns from the sea, does it so unerringly find its way back to spawn in the very headwaters where it was born?



During their ocean migration, sockeye salmon from Bristol Bay, Alaska, completed these circuits before heading back to spawn in home waters.

To begin with, every species, including the Atlantic salmon (*see* "Melancholy Fate of *Salmo Salar*," Natural History, June-July, 1967), comes from a pink egg, the size of a buckshot, that was buried in the gravel of a cold. swift-running stream. The incubation period is greatly affected by water temperature, but usually the eggs. deposited in the fall, hatch in the spring. The fry are tiny, translucent fish, with black eyes, spotted backs, and yolk sacs still attached to their bellies.

Their first year's growth is quickest in summer, when their food supply of insects is most abundant. As with human beings, the first year is the most precarious. The Canadian biologist R. E. Foerster estimates that of two million eggs. borne by 500 females and fertilized. 950,000 fry will be produced, but only 19,000 smolts will go to sea. The eggs are sought by bottom organisms such as crayfish; the fry are devoured by many kinds of predators.

As the remainder develop into smolts, physiological changes occur. Parr marks disappear, tails lengthen and become more deeply forked. The bodies acquire a silvery color, possibly from deposition of guanine in the skin.

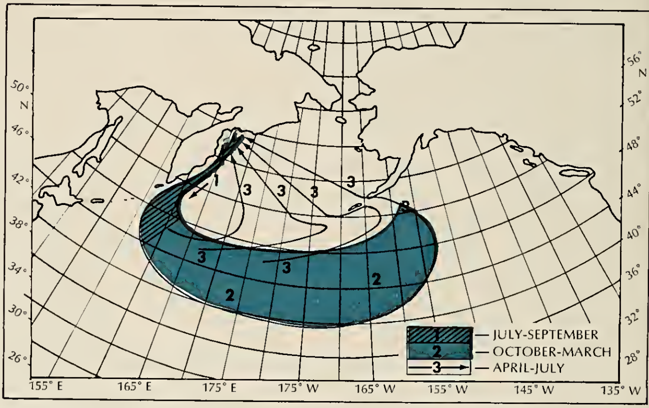
The length of time the young fish remain in their river or lake varies with the species, as shown by the table on page 48.

Pink salmon generally begin to move seaward immediately upon emergence from the gravel. Where the ocean is near, perhaps no more than ten miles. the course may need no more than one night; but where—as on the Skeena River in British Columbia—up to 150 miles is involved, they linger in the stream bed during the day and resume their migration at night. However, some daylight movements have also been observed near the spawning areas under conditions of high turbidity or flood. At the tidal zone they form schools of many thousands and in bright daylight can be seen swimming near the surface.

Sockeye prefer to spawn in streams headed by lakes or in the lakes themselves. The young fish cannot survive unless they first spend one to two years in such sheltered environments. They leave from early May to the end of June in the second or third year of their lives. They are between three and four inches long, and their color is a blue-tinged silver (hence on the Columbia River this species is called blueback). They make phenomenal speed downstream and quickly leave the estuaries for the ocean proper. The chum fry are silvery and, like the pinks, go directly to sea upon hatching. Often the two species move together: at Hooknose Creek, British Columbia, it was found that the main nocturnal migration of chums began and ended about an hour after that of the pinks.

Coho usually choose waters close to the ocean when dropping their eggs, although some individuals may journey up to 400 miles inland. The juveniles remain in freshwater a full year and, like the sockeye, are more exposed than other species to floods, droughts, pollution, and predators. They may remain at sea only a little longer than they did in the stream.

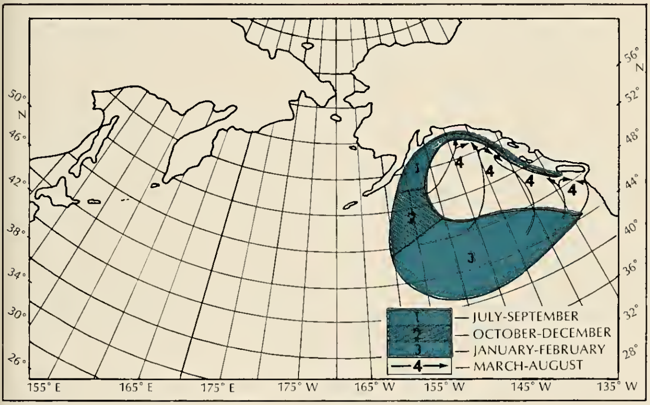
This is in contrast to the chinook, largest and heaviest of the Pacific species, which spends one or two



Here is the probable ocean-migration pattern of pink salmon from home waters in East Kamchatka, on the Siberian side of the Pacific.

years in the river and three or four at sea. Many chinook fry dash seaward soon after hatching, but most wait one or even two years. Chinook frequently reach weights of 50 pounds and up; specimens over 100 pounds are not uncommon.

The juvenile life of the salmon called steelhead trout resembles that of Atlantic salmon. They dwell in freshwater one or two or, occasionally, three full years before going to sea as fingerlings four to ten inches long and are therefore better equipped to survive the ocean's perils than some of the other Pacific species. After spawning, the steelhead, like the Atlantic salmon, may return to salt water, coming back to the river to mate a second and, rarely, a third time.



This ocean-migration pattern is of pink salmon stocks that originated in the rivers of British Columbia and southeastern Alaska.

When young salmon disappear into the sea, they embark on a journey that their ancestors have taken for thousands of years. The route is believed to be imprinted on their consciousness at birth. But acclimatization to the new environment comes later. After they have entered salt water, the large blotchy markings that were their protective coloration during stream life disappear, and silvery deposits accumulate on the skin and scales. Kidneys and cells in the gills adapt to sea water. In brief, the fish acquire highly efficient mechanisms for marine life and become capable of undertaking extensive peregrinations under the severe climatic conditions that often prevail in far northern latitudes. They feed voraciously and grow rapidly in size and weight until their sex cells ripen. This triggers a return to their natal stream.

Until fairly recently we knew very little about the Pacific salmon after they left freshwater. However, the great increase of fishing in the mid-Pacific, especially by the Japanese—creating serious conflicts and resulting in the signing of treaties—has led to a tremendous research program designed to reveal the salmon's movements. In this endeavor, many scientists from Japan, Canada, and the United States have cooperated for over a decade. Hundreds of thousands of fish have been tagged on both continents and the extensive recaptures give us a fairly clear picture of their wanderings over half the globe.

The salmon's main purpose in going to sea, where they spend their adult lives, is to exploit its rich pastures. They start their ocean life as plankton feeders, following the dense masses of microscopic animals drifting with the current. In time they develop strong jaws and fine teeth and can hold their own in the jungle that is the sea. They are able to devour crustaceans and smaller fish such as anchovies, pilchards, and herrings. Chinook and coho, for example, especially dote on herring, making them vulnerable to fishermen using herring as bait. As the salmon mature, however, they are pursued and eaten by sea lions, seals, sharks, dogfish, bass, and other predators.

The direction of the fishes' movements in the Pacific is now fairly clear. The major currents paralleling the North American coast travel northward so most of the fingerlings go that way. For example, the bulk of the Columbia River fish, after saying farewell to Astoria at the mouth of the river, may wander 700 miles, beyond the Queen Charlotte Islands, before they turn back to spawn. A small number, however, perversely head southward. Therefore Columbia River salmon have been caught as far south as northern California and as far north as Baranof Island.

The young Puget Sound migrant may spend a month or two in adjacent waters, calling on the San Juan Islands, or loitering in Tacoma Narrows. For instance, some Duwamish River salmon were found traveling up the coast at the rate of 25 miles a day before they circled westward and headed for the Gulf of Alaska. In general the movement of Pacific salmon issuing from North American waters is counterclockwise.

Dr. William F. Royce and his research colleagues of the University of Washington doggedly tracked large numbers of pinks from rivers in southeastern Alaska and British Columbia. After spending three to five months in estuaries, inner bays, and channels, these adventurers reached the ocean proper in July and headed rapidly northward and westward along the coast, following what oceanographers call the Alaskan Gyre. They averaged ten to twelve miles per day for months on end. In late fall and midwinter they reversed direction and moved south, and in January and February were spread widely over the Pacific, between 41 and 51 degrees north latitude and 130 and 160 degrees west longitude, still hitting a speed of ten miles per day—and gaining rapidly in size and weight. In the second spring and summer of their two-year lives, they left the midocean and raced northward towards their home rivers, sometimes averaging 45 miles per day! From sample catches, the size of this band at its peak was estimated as at least 750,000 fish passing daily, for 30 to 60 days, any given line of latitude in southeast Alaska.

Pink salmon make one such elliptical 2,000-mile circuit in their lives, but chum and sockeye, which stay longer in the ocean, may make two or three circuits and travel 10,000 miles before returning to spawn in Alaska, British Columbia, or Puget Sound. In 1964 it was estimated that a half million sockeye, which had been at sea one year, passed daily in a westward direction south of Adak Island from late June to late August—a total of some 30 million fish.

Asian species likewise make long-distance treks. Fish issuing from east Kamchatka's streams follow the East Kamchatka current southwestward along the coast and then head eastward, sometimes going as far as the western part of the Gulf of Alaska. American purse seiners haul them in, scarcely 18 inches long, as they cannily pick their way through the 1,500-mile-long string of the Aleutian Islands, where much of Oregon and Washington's bad weather originates.

At times, schools of North American and Asian salmon feed and travel together in cousinly fashion, but when the spawning urge strikes, each stock goes back to its own continent. Never has an American salmon been found spawning in an Asiatic river, or vice versa. The intermingling of stocks has generated continual conflict between the Japanese fishermen on the one hand and Canadian and American fishermen on the other. The North Americans claim that the Japanese, greedy to exploit the riches of the sea, are illegally taking salmon that were hatched in Alaskan or British Columbian rivers. To settle this conflict, the three countries in 1952 signed an international convention limiting Japanese fishing for salmon to a line west of 175 degrees west longitude.

Some of the Asiatic pinks—relatively small fish—are known to set unusual speed records, journeying more than 4,000 miles in 12 to 15 months before returning to their respective streams. Chum and sockeye may chalk up 2,000 miles in less than a year: on the homestretch they make 25 to 30 nautical miles a day for 30 to 45 days at a time, following the ocean currents.

How do the salmon accomplish their odysseys? Some of the detail are fairly well known by now. In the open sea, most species form compac shoals, swimming at fixed distances from each other. Schooling is an instinctive protective behavior pattern like the group flights of migratory birds. It seems to guarantee the survival of the maximum number of individuals under the pressures of intensive predation.

"All schooling fishes have wide-angle eyes with a broad lateral field," says ichthyologist F. D. Ommanney, "which is important in keeping the shoals together. They can keep a companion comparatively far in front and behind comfortably in view. But they have fixed immovable forefins . . . [and] must keep on swimming. They can swerve or veer but cannot stop, reverse or hover like solitary bottom fishes with movable forefins."

In true shoals the fish are spaced so that there is swimming room but not turning room between them. That is, no fish can turn around within the shoal without colliding with a companion. Although salmon travel in groups they do not apparently have the strong schooling tendencies

Data for six species of Pacific salmon occurring in North America and Asia

	Species					
	Chinook	**Pink**	**Sockeye**	**Coho**	**Chum**	**Cherry**
Length of time young stay in freshwater	few days to 2 years	few days	few days to 3 years	1 to 2 years	few days	1 year
Length of ocean life	1 to 5 years	1⅓ years	½ to 4 years	1 to 2 years	½ to 4 years	1 to 2 years
Life at maturity, years	2 to 8	2	3 to 7	2 to 4	2 to 5	
Length, average inches, at maturity	36	20	25	24	25	
Length, range, inches, at maturity	16 to 60	14 to 30	15 to 33	17 to 36	17 to 38	
Weight, average, pounds, at maturity	22	4	6	10	9	
Weight, range, pounds, at maturity	2½ to 125	2 to 9	1½ to 10	3 to 30	3 to 45	8 to 20
Principal spawning months	Aug.-Sept.	July-Sept.	July-Sept.	Sept.-Dec.	Sept.-Nov.	
Fecundity—number of eggs	5,000	2,000	4,000	3,500	3,000	

RANGE OF PACIFIC SALMON

	North America	Asia
Chinook, king, spring, etc. *Oncorhynchus tschawytscha*	From Monterey Bay, California, to Yukon River, Alaska, and Point Barrow. Abundant in Columbia and Sacramento rivers.	From Arctic Ocean to southern Kamchatka. Also reported in northern Hokkaido.
Coho, silver *O. kisutch*	From Monterey Bay, California, to Norton Sound, Alaska.	Does not enter Arctic Ocean but occurs in rivers along the Pacific coast as far as northern Hokkaido. Abundant in Kamchatka.
Sockeye, red, blueback *O. nerka*	From Klamath River in California to Alaska. Greatest concentrations in British Columbia and southeastern Alaska. Sparse above Bristol Bay; rare in Bering Strait. Does not enter Arctic Ocean.	Found in coastal rivers as far south as Hokkaido. Abundant in Kamchatka streams.
Pink, humpbacked *O. gorbuscha*	From Klamath River to northern Alaska, but scarce below Puget Sound. Abundant in British Columbian and Alaskan rivers. Found in Mackenzie River emptying into Arctic.	From Bering Strait along the coast of Asia as far south as the Amur River.
Chum, dog *O. keta*	From San Francisco Bay to Bering Strait but not plentiful south of Puget Sound. Plentiful on Arctic coast of Alaska, east to the Mackenzie.	Abundant in the rivers of Siberia, west to the Lena, especially in the Amur. South to Japan and Korea.
Cherry *O. masu*	Nonexistent.	From the mouth of the Amur to Pusan (Korea). Abundant in Japanese rivers.
Steelhead trout *Salmo gairdneri*	Numerous rivers from Alaska to northern California. Fairly abundant in the Columbia-Snake system.	
Kokanee, redfish *O. nerka kennerlyi*	Landlocked sockeye found in various lakes in Idaho, Oregon, Washington, and British Columbia.	

exhibited by herring, cod, and other marine species.

Dispersed over thousands of miles of the Pacific Ocean are hundreds of millions of Asian and North American salmon. Similarly, off the coast of Greenland, in Davis Strait, and in the North Sea the Atlantic salmon of Europe and North America—stocks from various countries—hold their rendezvous at appointed places, fraternizing and feeding together.

But how do the salmon navigate over the vast, trackless ocean? Dr. Royce and his colleagues suggest that their navigational ability results from an inherited response to environmental stimuli. As soon as they start out they seem to know where they are going; the circuits are traced, as it were, on their chromosomes.

Although salmon often follow the currents they do not drift. They swim near the surface, usually in the upper 30 to 60 feet, which makes it easy for netters or trollers to take them by the millions. Their schedule is remarkably consistent. "It is common," says Royce, "for a single interbreeding population to keep a schedule that varies from the average by only a few days." This is why their arrival in the home river is almost as predictable as that of a scheduled airliner.

Various investigators have produced theories to account for the feats of these fish, which seem to be masters of oceanic navigation although they lack any of man's navigational equipment. The Canadian M. C. Healey studied the migration of pink salmon fry from the Bella Coola River in British Columbia and concluded that celestial clues must have aided them in getting out to sea. The minuscule fish were better oriented, he says, on clear days than on cloudy ones. Dr. A. B. Hasler suggests that the fish navigate, at least partly, with the help of measurements from the sun on clear days—although along the Pacific routes there are few clear days from one end of the year to the other. Around the Aleutians the skies are persistently overcast, with winds blowing almost continually and storms roiling the seas. Even in the milder summer periods, the sky is persistently hidden by fog, mist, haze, or clouds. Closer to the coast, the same mixture prevails. In the outer parts of Bristol Bay the average weather in June, when most of the salmon are homeward bound, is 44 per cent fog, mist, or haze, and the cloud cover is frequent. In the central Gulf of Alaska, which teems with salmon, the average June weather is 25 per cent fog, mist, or haze; cloud cover is even more frequent. Consequently, many scientists are inclined to question the sun-measurement theory.

We know that salmon navigation is unrelated to any landmarks, such as continental shelves. The fish seem to find their way easily in waters that often confuse human mariners equipped with loran and other devices. Pinks from Asia, for instance, were tagged and dumped at widely different points in the ocean and all those later recaptured had apparently gone straight home. Similar experiments with Alaskan salmon brought the same results.

Does the salmon use its olfactory sense as a navigational aid, as Hasler and some other biologists claim? Dr. Neave of the Canadian Fisheries Research Board rules out this theory except as it might apply when the fish nears home waters. Since every body of water has a unique chemical composition, it is possible that the salmon, remembering their natal stream from babyhood, somehow detect its smell as they near the coast, and head for it. This might explain, for example, how coho return to the little hatchery pond on the busy campus of the University of Washington in Seattle. To reach the hatchery they must chart a course through the intricate network of Puget Sound waters, crowded with ferries and other boats, then reach the pond through a maze of relatively still watercourses (water for the pond is pumped out of Lake Washington and adjacent springs).

On the other hand, Royce's group leans to the belief that salmon navigate with the help of infinitely small electrical voltages generated by the ocean currents as they travel through the earth's magnetic field. Some species of fish are known to have electric organs as well as electroreceptors, but "no investigations are known concerning the electrical sensitivity of adult salmon or of the presence of receptor organs in the lateral line of salmon which might be electrically sensitive."

These investigators conclude that "the salmons' migration cannot be performed if they travel or drift at random, or if they depend on any memorized visual or olfactory cues at any time except during the final location of the home estuary and stream. . . . We suggest, therefore, that salmon may depend on electromagnetic cues from ocean currents . . . [and] that their response to all migratory cues is inherited, not memorized."

Other biologists suggest that the fish possibly depend upon varying salinities in the ocean or perhaps take measurements from the moon. But all we know for certain is that their delicate perceptiveness not only enables them invariably to find the proper river but also leads them upstream to the exact tributary which may be no more than a slender creek or burn, from which they emerged as juveniles. To reach it they will have to pass and ignore many other streams in the watershed.

Whatever the navigational method, as salmon approach the coast their bodies undergo perceptible changes. Blood, tissue, and vital organs age rapidly. The different species, varying in size, look superficially alike in the sea, graceful creatures with gleaming silver backs; but with sexual maturity, each acquires distinct colorations and to some extent shapes, so that they cannot be mistaken as they nose their way up the rivers. The bodies of both males and females are markedly compressed, the skin thickens, and scales are absorbed. The male develops a hook jaw and the female is distended with roe. Sea lice acquired in the sea are shed. The pinks, in their spawning livery, turn slate gray on the back and sides and creamy white on the ventral surface; chum acquire a mottled gray color, yellow on the back and sides; the big chinook and the coho alike tend to turn dark red; sockeye are perhaps the most remarkable for their bodies are fiery red and their heads olive green.

The homeward trek is so timed as to enable the fish to arrive when ecological conditions—flow of water, temperature, turbidity, and oxygen content—are most favorable for ascent of the rivers. Relatively few individuals fail to find their home waters, although many linger a while in coastal areas. The homeward travelers are met in the coastal waters, bays, and estuaries by fishing fleets with their purse seines, drift nets, or trolling gear. This ends the journey for a large proportion of the runs.

Intent to spawn where th
were born, adult socke
wriggle and pick their w
up the shallow strea

The oceanic existence has already taken a heavy toll of each generation, especially in the earliest days when the fish must adjust to their new environment and fight off a host of predators. Foerster hazards a guess that of the 19,000 young sockeye who head for the sea out of a spawning population of 1,000 adults (500 males and 500 females), 90 percent die and 10 percent return to the river, or about twice as many as spawned originally. He goes on: "If, on the other hand, we assume a 20 percent survival, as was found for Karluk Lake, Alaska, 2,800 adults will return . . . if there is a 33 percent survival, as found in Lake Dalnee, Kamchatka, then 7,270 adults will return. . . . For the Fraser River and the Columbia it has been indicated that . . . 5 fish return for every spawner." These figures are only hypothetical, says Foerster, a composite derived from many areas. But if the runs are to be maintained, at least one adult must return and reproduce for every fish that spawned in the previous generation. This ratio is becoming difficult to achieve in many parts of the salmon's range, even with wise regulation of catches.

Races of the same species enter the rivers at different seasons, and each has its well-timed appearance. Thus in the British Isles there are winter and spring runs; in the Russian rivers flowing into the White Sea one of the groups appears in the autumn when its gonads are feebly developed, and does not spawn until the following year. The other group ap-

Continued on page 66

Venus, Star of Sweet Confidences

by S. I. Rasool

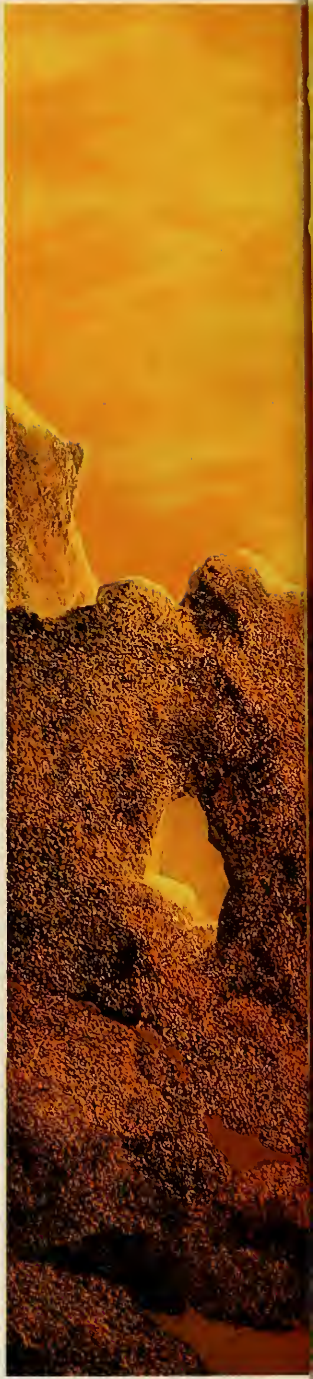
The planet Venus has been a symbol of beauty from the beginning of civilization. To the Babylonians it was "the mistress of the heavens," and to the Chinese, the "beautiful white one." The name itself was first applied to the "goddess of spring and love." The planet has also been called "the bearer of light" and "the shepherd star, the star of sweet confidences."

Galileo was the first to look at Venus through a telescope. He turned his newly invented instrument on the planet in 1610 and immediately made an important discovery: Venus displays phases like those of the moon. This discovery constituted the first, and for 115 years the only, proof that Venus—or any planet—revolved around the sun rather than the earth. The astronomer described his finding with a phrase in keeping with the notion of the planet: "the mother of love emulates the shapes of Cynthia [the moon]."

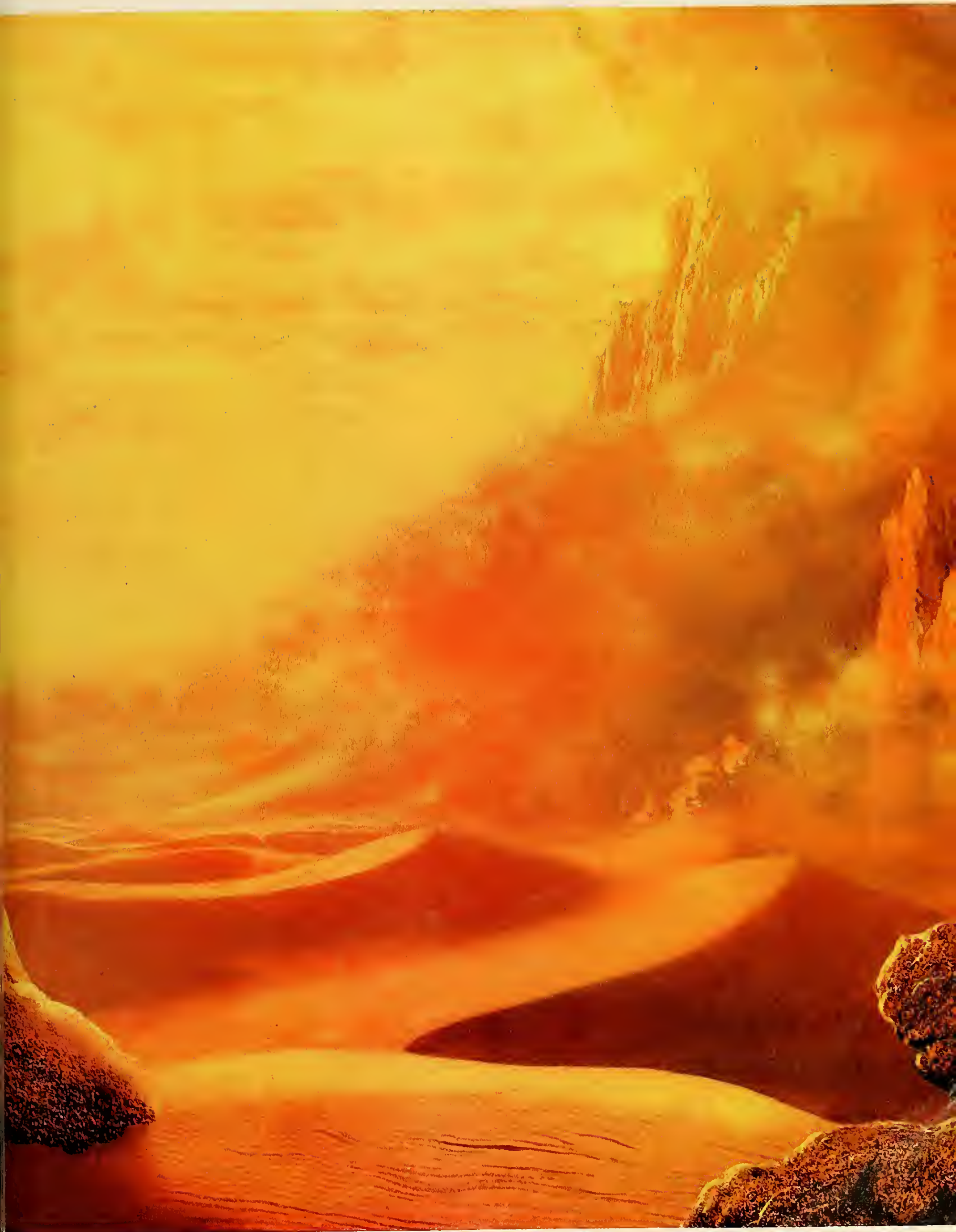
Romantic interest in Venus grew during the seventeenth and eighteenth centuries. Enthusiasm for the climate and the potential inhabitants of Venus mounted after careful telescopic studies revealed that Venus was similar to the earth, with 80 percent of its mass and 95 percent of its diameter. These discoveries, combined with the knowledge that the planet was roughly the same distance from the sun as the earth, gave rise to the classification of Venus as our sister planet in the solar system. Her face concealed from our gaze by a veil of clouds, she afforded the prospect of an excellent climate for the life with which we are familiar, and until about 15 years ago, hope flourished that beneath the cover of clouds lay teeming masses of flora and fauna in a tropical paradise "more luxuriant than the virgin forest of Brazil."

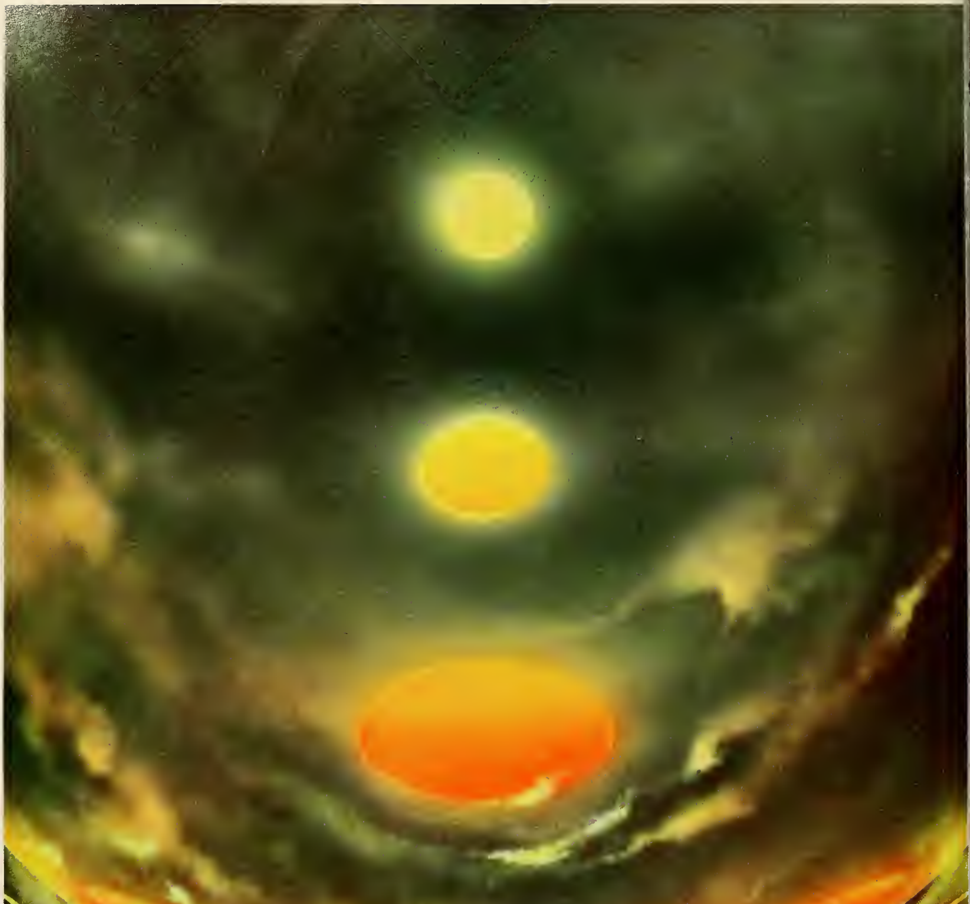
In the last 15 years, however, an entirely different picture of the surface and atmosphere of Venus has emerged, based on the findings of radioastronomy and the more recent space probes. Convincing evidence has been accumulated indicating that the surface of Venus may be a sizzling 800°F., and that its atmosphere, about 20 to 100 times heavier than that of the earth, is largely made up of carbon dioxide, and almost completely devoid of free oxygen and water vapor. Thus, there seems to be no chance of finding terrestrial-type life on the surface of the romantic planet.

The extremely inhospitable nature of Venus's surface and atmosphere has been confirmed and elaborated in recent years by the spectacular success of two space probes, the Soviet Venera 4 and the American Mariner 5. Launched within two days of each other in June, 1967, the two spacecraft traversed elliptical paths of approximately 200 million miles and arrived in the vicinity of the planet four months later on October 18 and 19, 1967. The routes of the spacecraft diverged as they approached Venus. Drawn toward the planet by its gravitational pull, Mariner 5 swerved across the dark side, over a portion of the sunlit hemi-



The surface of Venus, as conceived by the planetary artist, Chelsey Bonestell. The painting dates from about 1950.




H.K.W.

phere, and out into space. Venera 4, eading directly for the planet on a ollision course, ejected a capsule hat parachuted to a soft landing near he Venusian equator, radioing back nformation as it descended, in an extraordinary feat of planetary exploation.

How were temperature and atmosheric measurements made by these wo probes? Venera 4 contained a imple thermometer, a barometer, nd several gas analyzers, which made direct measurements of temperature, pressure, and the atmospheric composition at different points as the capsule descended toward the planet's surface. The first measurement was made at a point 32 miles above the surface, where the temperature in the atmosphere was 80°F. At this point, gas analyzers indicated that the atmosphere was composed mainly of CO_2 (95 percent, as compared with the earth's 0.03 percent) and contained only very small amounts of water vapor (0.1 percent). At approximately the same altitude, the parachute opened and the spacecraft began its slow descent. Temperature was measured at frequent intervals throughout the ensuing parachute drop and was found to be increasing at a rate of 5°F. every 1,000 feet. At the point where temperatures had attained a value of 540°F. and where the pressure was about 20 times that of the earth's atmosphere, the signals from the spacecraft stopped abruptly.

At first, astronomers believed that the signals had ceased because the capsule had reached the surface of Venus; however, a critical analysis of this data, in comparison with that of Mariner 5, subsequently indicated that at the time the signals from Venera 4 stopped, the capsule was still about 16 miles above the surface. The temperature and pressure values at ground level are probably much higher than those recorded and radioed back to earth.

n Venus a "day" lasts for a
riod equal to 110 earth days. As
e sun "sinks" toward the horizon
nd if the sun can be seen through
e cloud layers), its appearance
changed by Venus's dense lower
mosphere, from a circle of
ld to a concave slice of red.
milarly, light rays reaching
enus are severely bent, distorting
e landscape and giving the
npression of looking up from the
side of a large bowl.

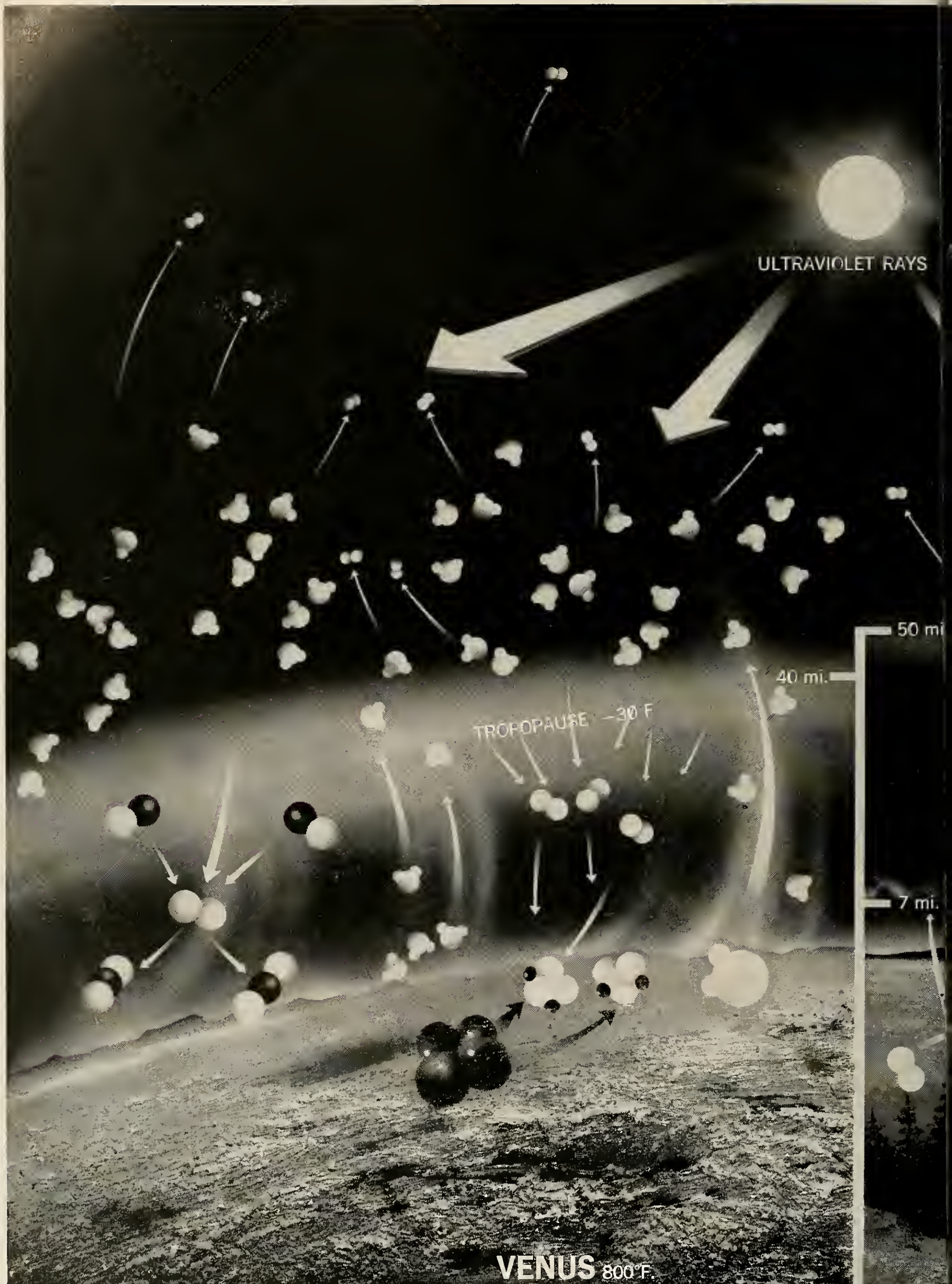
Although Mariner 5 did not send a probe to the surface of Venus, it acquired information on conditions deep inside the atmosphere as its trajectory carried the spacecraft behind Venus. While on the dark side, radio signals from the spacecraft to the earth were blocked for a period of about 20 minutes. Prior to its passage behind Venus, and again just after its emergence on the other side, the signals from Mariner 5 traversed the Venusian atmosphere en route to earth. As the beam penetrated the Venusian atmosphere, refraction caused its path to deviate from a straight line, and its velocity to vary from the speed of radio waves in free space. In addition—because the density of any atmosphere decreases with altitude—as Mariner's signals were transmitted through increasingly lower and denser levels of the Venusian atmosphere, the beam was spread over a greater angular width causing the signal power received on earth to decrease progressively. From the measured rate of change in frequency as a function of time, it is possible to deduce the density distribution in the atmosphere. If the composition is known, temperature and pressure profiles follow. Since the Soviet space probe indicated that Venus's atmosphere is 90 percent CO_2, incorporating this information into the data provided by American Mariner 5 should, in principle, enable one to determine a profile of atmospheric conditions down to the surface of the planet.

However, because of the high density of the planet's atmosphere, the radio signals from Mariner 5 were bent through so large an angle as they passed through the lowest layers of the atmosphere that they never reached the earth. At the lowest depth probed, the atmospheric temperature was 320° F. and the pressure about 7 atmospheres; both were still increasing. Data acquired on atmospheric conditions at higher altitudes were sufficiently accurate so that they could be extrapolated downward to the surface with reasonable reliability. But in extrapolating the Mariner 5 data to Venus's surface an important question arises: namely, where is the surface?

Tracking data gathered during the flight determined the position of Mariner 5 with respect to the center of the planet; consequently, Venus's atmospheric conditions are known in terms of distances from that point. These can be expressed as altitude above the surface provided the radius of the solid planet is known. Fortunately, radar observations of Venus yield extremely accurate determinations of the motion of that planet in its orbit around the sun, and yield its radius as a by-product—a value of 6,052.5 kilometers (3,783 miles).

If Mariner 5 data are extrapolated downward to 6,052.5 km., with the same rate of change of temperature and pressure as encountered in the atmosphere above, the projections indicate a surface temperature of 800°F. and a surface pressure in the neighborhood of 75 atmospheres. And if, as in the case of earth, the composition of Venus's atmosphere remains uniform at various altitudes, then it is likely that the planet's lower atmosphere is mainly composed of carbon dioxide instead of nitrogen and the life-sustaining oxygen of earth. These extremely rigorous conditions on the surface of Venus are most intriguing for a student of planetary evolution. Another finding is that no more than 0.1 percent of water vapor was observed in the lower atmosphere of Venus. If condensed to a liquid, this amount of water would cover the surface of Venus to a depth of only one foot. The amount of water in the oceans of the earth is much greater: if spread uniformly over the surface of the globe, it would form a layer about 8,000 feet deep.

According to current views on the origin and evolution of our solar system, the nine planets and the sun were formed at the same time, 4.5 billion years ago, from the same homogeneous mass of gas and dust—the "primitive solar nebula." Since Venus and earth had the same composition at the start, it would seem

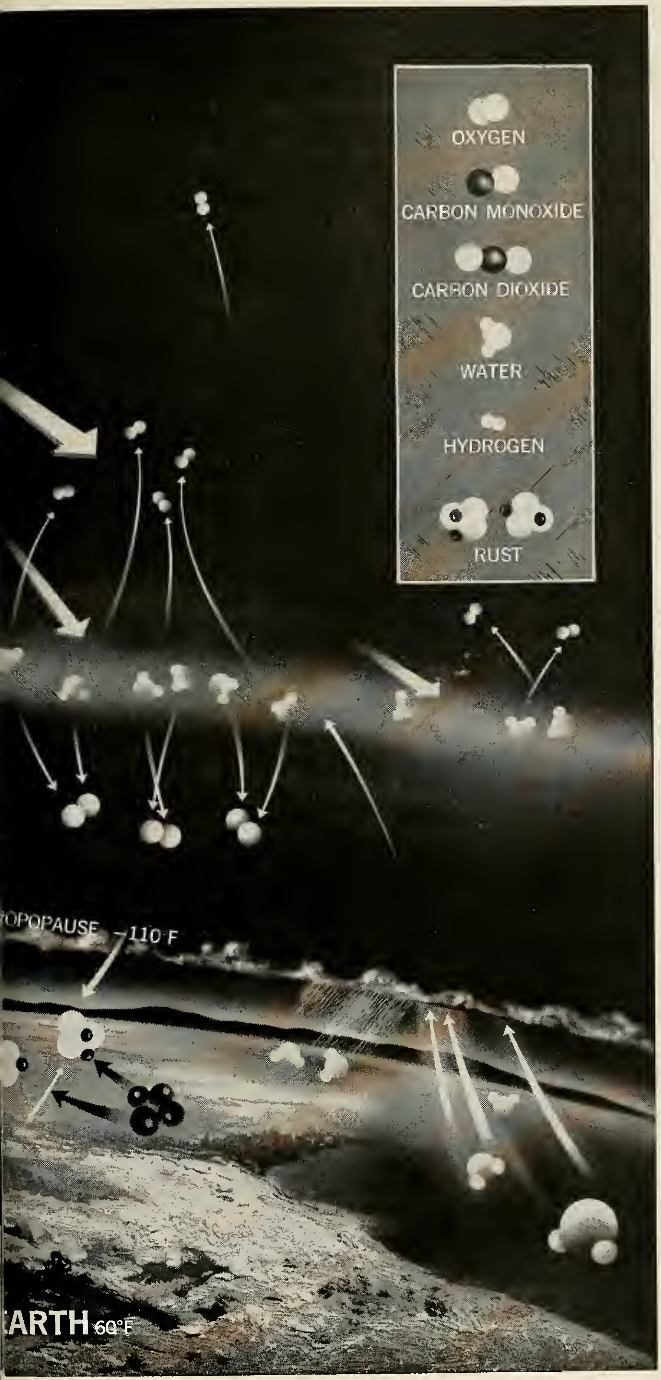

ULTRAVIOLET RAYS
50 mi
40 mi.
TROPOPAUSE −30°F
7 mi.
VENUS 800°F.

that Venus's surface should also be covered by an ocean 8.000 feet deep (or by a layer of "steam" resulting from the 800°F. temperature of the surface). Venera 4, however, showed that most of this water is missing.

Why did two planets so alike in size and mass, probably formed at the same time out of similar materials, and situated at comparable distances from the sun, evolve along paths sufficiently different so that one offers an excellent climate for life while the other offers conditions hostile to terrestrial organisms? This question may be broken down into three components: Why is the surface of Venus so hot? Why does its atmosphere contain such large quantities of carbon dioxide instead of nitrogen and oxygen as on the earth? What happened to the oceans on Venus?

The abundant presence of carbon dioxide on Venus—about 70,000 times more than on earth—helps pro-

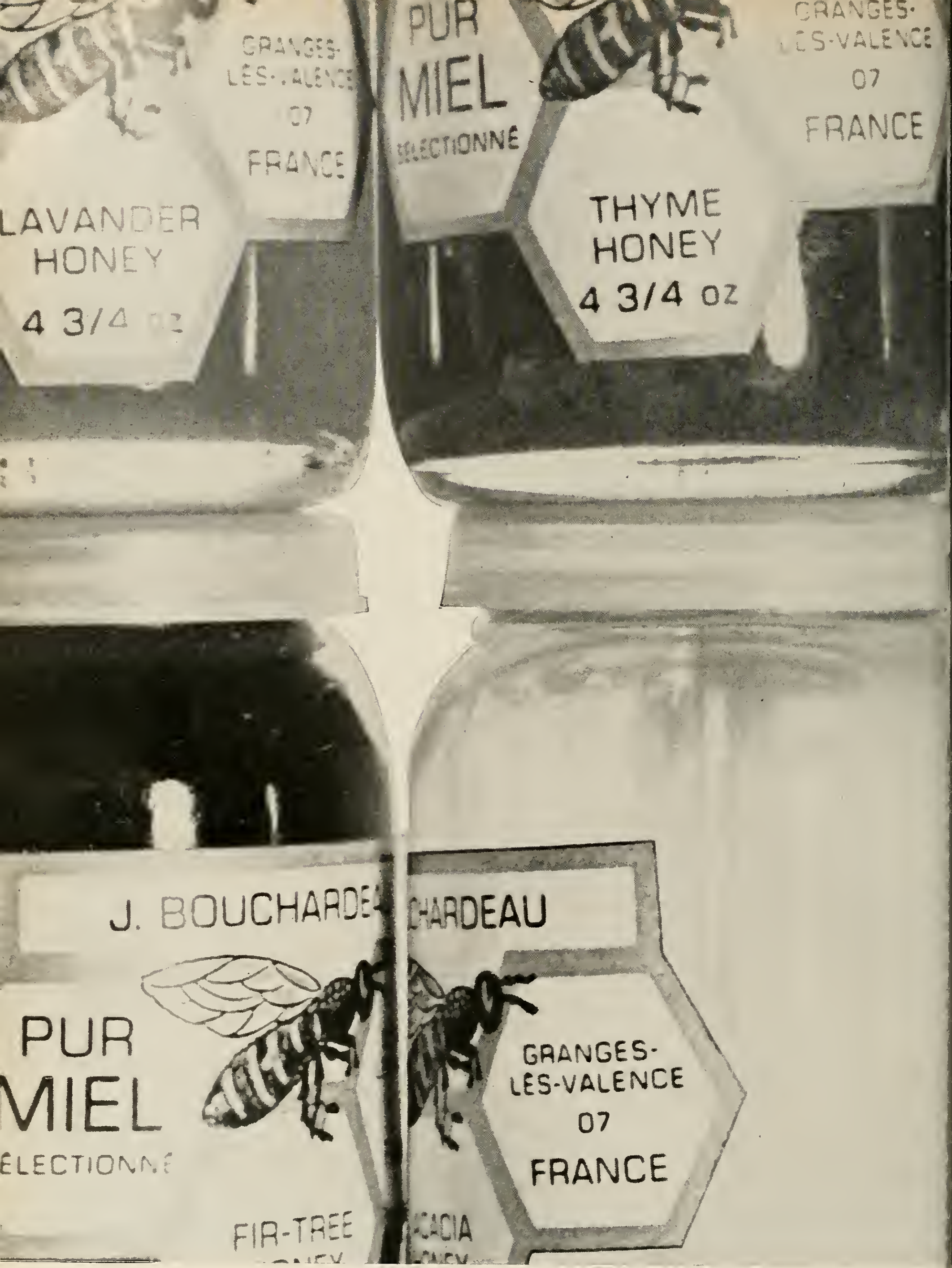
Continued on page 68



EARTH vs. *VENUS: Relative to earth, Venus is hot and dry; its atmosphere contains little oxygen and much carbon dioxide.*

Only a small amount of water escapes earth. At a height of about seven miles, water vapor is condensed into clouds by the low temperature of the tropopause and returns to earth as rain. Venus's tropopause is much warmer and most water molecules are dissociated into hydrogen and oxygen. Hydrogen escapes the gravitational pull of the planet. Oxygen unites with elements in Venus's crust and with gases in its lower atmosphere to form ferric oxide (rust) and carbon dioxide, respectively. On earth, most atmospheric oxygen is supplied by plants through photosynthesis.

A dense layer of carbon dioxide in the Venusian atmosphere traps the sun's heat by means of the "greenhouse effect" (see text) and raises the planet's surface temperature to an estimated 800° Fahrenheit. The greenhouse effect operates less effectively on earth.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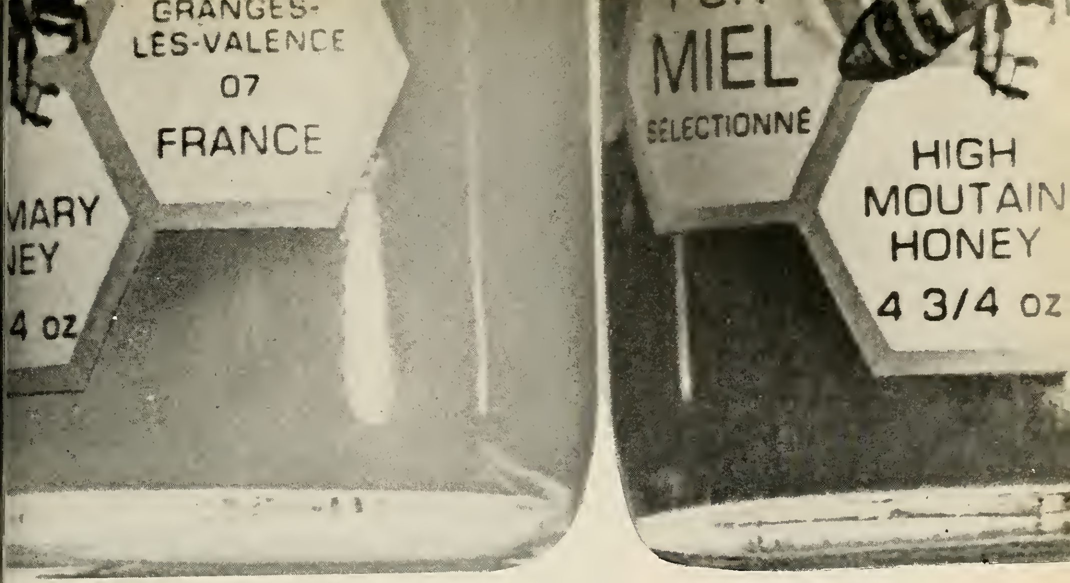


he Varied Fare of the Honeybee

Alfalfa, buckwheat, raspberry, thyme— a spectrum of nectars transformed in the hive

by Roger A. Morse

At beekeepers' summer picnics, I have judged honey shows in hich a single amateur beekeeper is displayed a nearly water-white ney from basswood or alfalfa, a rk or almost coal-black honey om buckwheat or privet, and an nber honey from goldenrod—all oduced in the same year from only e or a few hives of bees. The tastes these honeys are as varied as their lors. In fact, no two beekeepers ve honey that is exactly alike, a markable occurrence due, not to y inconstancy on the part of the neybee. but to the soil type, moisre level, and topography, as well as the flower species in bloom in the ea. Moreover, a prized honey may made from nectar that the bees thered from more than one floral urce and mixed naturally in the ve—as they often do. The strong vor of wild thyme honey, for exmple, may be diluted to an excellent end when mild-flavored alfalfa is thered simultaneously.

The amateur beekeepers—who own one, ten, perhaps up to fifty hives—like to discuss the intricacies of bee biology at these summer picnics and shows. Conversation runs from the rearing of queens to the capturing of wild swarms, but the keepers can also be counted on to compare notes about one of their favorite pastimes—keeping a hive of bees on scales and watching its day-to-day weight change. Since a colony of bees sometimes gathers as much as fifteen pounds of nectar in a single day, this can be an exciting change to watch. When a rapid increase takes place, the beekeeper immediately searches for the plants yielding the bountiful nectar supply. Often he can determine this merely by smelling the area around the hive, since each honey has a distinctive odor. In fact, such a strong odor emanates from an apiary containing a honey such as buckwheat or goldenrod that when there is a good honey flow, the plant source can be identified from a hundred or more feet away. To keep the honey as pure as possible, the beekeeper must be alert to the vagaries of the flows—the availability of particular nectars—as the honey must be removed promptly and a new comb put back into the hive for the next flow.

The cultivation of honey is an ancient art. The early Egyptians were beekeepers, moving their colonies up and down the Nile and taking advantage of the succession of nectar-producing flowering plants that followed the annual floods. Beekeeping was important to the Egyptians because they did not yet grow sugar cane, and until the seventh century A.D., they were dependent upon honey and fruits for their sweets. Scenes of Egyptian beekeeping have been found in several tombs, and in certain areas in Egypt today bees are still kept in the same type of tiered mud hives.

With the impetus from the Egyptians, it is not surprising that the

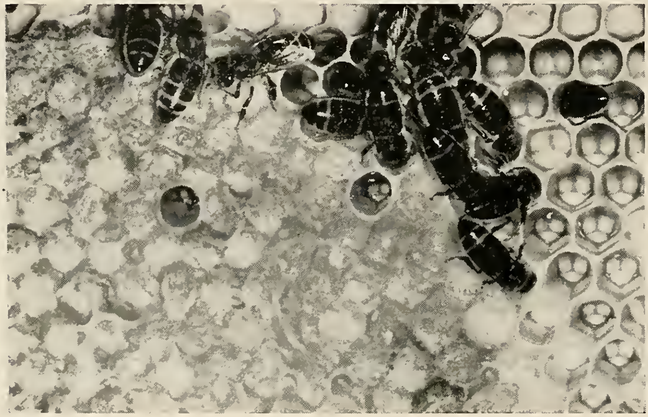
Greeks had a well-developed beekeeping industry. Wild thyme honey, with its strong flavor and distinctive reddish tinge, was called the "nectar of the gods" by the Greeks more than two thousand years ago. When in bloom, the low-growing thyme gave the hills a purple hue. Greece's Mount Hymettus is still the best-known honey-producing area in the world.

A small amount of Mount Hymettus honey is available in this country, but most wild thyme honey sold here comes from the Catskill Mountains and an area east of Albany, New York. The shallow-rooted plants do not need rich topsoil to flourish; much to the consternation of farmers, who consider the plant a weed, thyme grows well on pastures in the hilly areas. Just as in Greece, the flowering thyme gives hillsides in the Catskills a rich, purple color in August and early September when there is sufficient rain.

Honey can be made from many kinds of flowering plants, but only honeybees can make it. They collect the flower's sweet, sugary nectar and change it physically and chemically into honey. One might logically ask why all nectars are not alike, and the answer is simple. Flowers have different nectars, just as they have different structures, colors, growth forms, flowering times, etc. Honeybees use these characteristics to distinguish one flower from another. A bee's eyes and sensory receptors detect each of these qualities, for whil bees do not see quite as well as man their ability to detect odors and varying levels of sweetness is much bette than that of man.

The bees take nectar and chang it to suit their own needs, but the do not change the basic flavor o color. The strongest and darkes honey produced by honeybees i buckwheat, my favorite. Thirty year ago, it was was one of the commones and cheapest honeys on the marke but today it is a rare commodity

In search of new hive site, swarm of workers clusters around its queen. Below, bees store honey by filling and sealing comb cells.



commanding a premium price. This change in its fortune occurred because there is now little demand for buckwheat, a grain high in fiber and low in protein, which cannot compete with corn and wheat as an animal feed. Consequently, few buckwheat plants are presently available to bees, whereas formerly nearly every farm in the northeast, especially the hillside farms, would have a field covered with snow-white buckwheat flowers in August.

Turning to the opposite end of the spectrum of honeys, we come to raspberry, one of the most delicate honeys in color and flavor. Wild raspberries, not the cultivated varieties, produce most of the raspberry honey on the market, but it is not an easy task for the beekeeper to find large fields of wild raspberries from which his bees can gather a honey crop. On some of the poorer agricultural soils in the northeastern states and Michigan, however, where farmland has been abandoned, there are large fields of wild raspberries that yield considerable quantities of nectar. Unfortunately, the raspberry, like many plants, does not produce a surplus of nectar every year; favorable weather conditions are needed for nectar secretion.

Honeys that are light in color are generally mild in flavor, while dark honeys tend to have strong flavors. But there are notable exceptions. For example, basswood, a light honey used by packers to lighten the final color of honey blends, has a slightly minty taste that is objectionable to many people if too much is added. Basswood honey is more common today than it was several decades ago, because as farms are abandoned in the northeast many of the fields have grown up to woods that often contain many basswood trees. Some cities, too, have found this tree suitable for roadside planting, thus providing bees with an added source of basswood nectar.

Besides the array of honey colors and flavors that derive from different floral sources, the characteristics of an individual type may vary as well. When weather conditions are favorable, orange blossom honey may be light in color, mild in flavor, and have a heavy body. On other occa-

A Geographic Honey Sampler

With beekeeping an almost universal occupation, it is not surprising that perusal of gourmet food departments in big-city stores might turn up honeys as common or exotic as these:

Acacia	*Rumania*
Algaroba	*United States*
Apple blossom	*United States*
Avocado	*United States*
Bird's-foot trefoil	*United States*
Black locust	*Italy*
Blueberry	*United States*
Coffee	*Central America*
Dandelion	*United States*
Desert blossoms	*United States*
Eucalyptus	*United States*
Fireweed	*United States*
Goldenrod	*United States*
Heather	*England*
Lavender	*France*
Leatherwood	*Tasmania*
Lehua and kiawe blossoms	*Hawaii*
Lemon blossom	*Greece*
Lima bean	*United States*
Lime blossom (basswood)	*Poland*
Linden (basswood)	*Holland*
Logwood	*Jamaica*
Mandarin orange	*Japan*
Milk vetch	*Japan*
Orange blossom	*Israel*
Peppermint tree	*Australia*
Privet	*United States*
Rape	*Holland*
Rosemary	*Spain*
Sage	*United States*
Star thistle	*United States*
Tulip tree	*United States*
White clover	*New Zealand*
White gum	*Australia*
Wild flowers	*Guatemala*
Wild raspberry	*United States*
Wild rose	*Greece*
Wild thyme	*Greece*

sions, usually when the orange-blossom nectar flow is prolonged, the honey is much darker and often too strong for table use. Also, high humidity may make it difficult or impossible for the bees to remove enough water from orange honey, leaving it too thin and affecting its taste.

Because honey color has a profound effect on marketing, honeys have been examined to determine how their color variations are related to their chemical makeup. Generally, the darker honeys have more acid, nitrogen, ash, and complex sugars. It is probably the higher amounts of these contents that cause their more exotic and distinctive flavors. The darker honeys have more food value, but most beekeepers prefer to sell their honey on the merits of its distinctive taste rather than on its food value. The lighter honeys generally tend to granulate more rapidly than the darker ones, and the percentage of the simple sugars, levulose and dextrose, is greater in light honeys.

The highest-priced honey produced in the United States is tupelo honey, which comes only from west Florida, mostly along the Apalachicola River. There are no roads into this honey-producing country and colonies of bees are barged downriver for the honey flow. Since the area in which the tupelo trees grow is a huge swamp, subject to frequent flooding, the colonies are transferred from the barges to wooden platforms ten to twelve feet high. Gasoline engines must be carried to the apiaries to run the machinery that removes liquid honey from the combs in which it has been stored by the bees.

Along the banks of the swampy Apalachicola River there are no other major honey plants during the summer months, and the bees would starve if not moved out of the area. Although moving bee colonies on specially built barges is costly, tupelo honey is so highly regarded by many people that they are willing to pay a premium price for it. In addition to its fine flavor, tupelo honey is very slow to granulate, and consequently much of it is sold to the drug trade for use in combination with certain medicines.

Beekeeping then and now: traditional twisted straw skep, above, has been replaced by hives with movable frames, right.

The most common honey in the United States is that produced from alfalfa, although it is seldom sold under that name. Honey from the legumes, alfalfa included, is usually light in color and has a mild, delicate flavor. This is the honey preferred by the average American. Legume honey is usually sold under the name "clover honey" or "clover blend."

While man delights in producing and tasting the multitude of honeys produced by bees, it must be remembered, too, that honey is the adult bee's chief food. Biologically, one of the characteristics that separates bees from other insects is that not only the adults but also their developing larvae feed exclusively on pollen and nectar.

Bees, like all insects, are cold-blooded animals and assume the temperature of their environment. With the advent of cold weather, colonies of honeybees form a dense cluster and generate heat. As the bees on the outside of the cluster become cold, too cold to move, warm bees from within the cluster move to the outside and push the cold bees into the cluster where they again become warm. If this rotation of bees in the cluster did not take place, the bees would slowly freeze to death. Honey is the chief source of energy for the bees in the winter cluster. In the northern states a normal colony of bees will consume sixty to eighty pounds of honey in the winter and early spring. While a beekeeper may harvest one hundred pounds of honey from a single colony, it is estimated that a normal colony collects five to six times this amount of honey for its own use.

If not enough surplus of a particular honey is produced, it may be quite rare on the market. In the case of apple blossom honey, for example, bees collect almost no surplus. In most areas in the United States apples flower during May, when the honeybee colony populations are increasing in preparation for the major honey flows that occur later in the summer. Bees, at least in the northern states, rear the greatest quantity of brood during May and June; as a result, incoming nectar is used for feeding the young almost as fast as it is collected. Bees may store a small surplus of apple blossom honey but seldom more than ten or fifteen pounds. Beekeepers who take this honey from the hive usually feed the bees so that they can sustain themselves until mid or late June. Once in a while, one will find a small amount of apple blossom honey—whose delicate flavor is similar to that of raspberry honey—in a specialty store.

When bees collect nectar and make it into honey, they change it in two ways. The chief sugar in nectar is sucrose, a 12-carbon sugar. Bees add an enzyme, invertase, to the nectar, and this converts the 12-carbon sucrose into two 6-carbon sugars, levulose and dextrose. The chemical breakdown of sucrose is started by the bee before the honey is stored. This is beneficial to the bee and to other animals, such as man, who eat the honey. Honey may contain as much as 8 percent sucrose, but generally there is much less present.

The second way in which bees change nectar is to remove much of the moisture. This not only means that less storage space is required but the growth of yeasts, which might result in premature fermentation of the product, is deterred. The bees use a simple process to remove water from honey. The nectar is taken from the field bees by house bees, which in turn spread it in various cells in the honeycomb so that as much of the nectar's surface as possible is exposed. Other honeybees, called ventilators, station themselves in various positions within the hive, but especially at the hive entrance. Using their wings, they move large quantities of air through the hive, evaporating the excess water. As new nectar is collected it is distributed in the cells on top of the nectar from which a sufficient amount of moisture has already been removed.

Because of their need for honey, it is obvious that the prosperity of a honeybee colony is tied closely to the quantity of flowers in an area, as well as to the quantity of nectar they produce. But at the same time, flowering plants depend upon bees.

While honey is the important consideration for the bee, pollination is the important factor for the flowering plant, and the biological function of its nectar is to attract bees for this purpose. The nectar is a bribe or reward; without it there would be little cross-pollination. Honeybees are not the only animal species that carry pollen—the male element in flowers—from the male to the female parts of the flower. However, they are the most common and efficient animal agents of cross-pollination.

Plants appear to cooperate to make the gathering of food easier for the bee. Generally speaking, plants that bloom in the early spring produce more pollen, the protein portion of the bees' diet, than nectar, the source of carbohydrate. This is the time of year when bees are rearing their young and need more protein to do so. In summer and fall, most plants produce more nectar than pollen. During these seasons, a colony of bees stores the food reserves it needs for winter, when it is more important for them to have honey than pollen, although some pollen must also be stored.

The small branched hairs covering a bee's body facilitate the carrying of pollen from one flower to another. While the bees use their legs to scrape much of this pollen into their pollen baskets for transport back to the hive and much pollen accidently drops from the bee's body onto the ground, there is still enough remaining so that the bee accomplishes the fertilization of the plant.

Honeybees have an unusual fidelity to a flower species. Individual bees, for example, go from dandelion flower to dandelion flower and do not move from dandelions to apple blossoms and then to a flower of another species. Exceptions may be observed, but the great majority of bees follow the same pattern. Not only will a bee behave in this manner on an individual trip from the hive, but trip after trip, day after day, the bee will follow the same pattern. An adult bee, in the active season, has a very short life-span, usually only six weeks. About three weeks of this time are spent in the hive as a house bee, and three weeks are spent as a field bee. With such a short period in the field we have observed that an individual bee may devote her whole life to pollinating one plant species.

Remarkably, and unlike all other social insects, bees do not mix their brood and their food supply. Brood, or young bees, are reared at a constant temperature of about 92° F., so it is important to concentrate them in one area. The brood nest therefore occupies the lower portion of the hive, and the honey is stored separately in combs above the brood nest. If bees did not separate their food reserves, it would be extremely difficult for man to harvest honey.

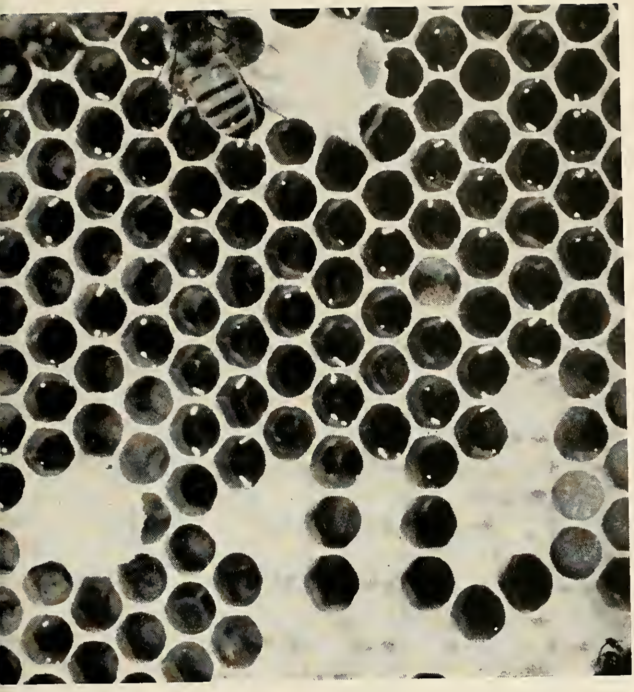
The growth of modern agriculture has made the honeybee even more important. The 1900 United States census showed that one farm in four had one or more colonies of bees. At the turn of the century our agriculture was diversified, but diversified agriculture is not as economical as intensified agriculture. Just as other farmers became specialists, so did beekeepers. Today it is not uncommon for one man to efficiently operate a thousand, or even more, colonies of bees. Some of these men transport their colonies hundreds and sometimes more than a thousand miles to produce a crop of honey.

A successful beekeeper must have a good knowledge of botany. He must know when the flowering plants from which his bees gather a surplus will bloom. He must understand how weather will affect nectar production. Sometimes a beekeeper has an opportunity to move his bees to two or more locations at the same time, and to make this choice he must know which source will give him the greatest yield, as well as which honey will bring the best price.

One question he is concerned with is the amount of water present in his honey. Honey naturally ripened by bees usually contains 14 to 19 percent moisture. Honey from the drier western states often has less moisture than that produced in the more humid eastern states. This can be a problem, because if the moisture content is 14 percent or less, the honey is so thick that it does not spread easily. On the other hand, honey with too much moisture will drip too much. So most honey packers blend their product so that it contains about 17.5 percent water—a happy medium.

More than half of the honey produced today is used by bakeries in special breads and cakes. Honey helps to retain the moisture conten of a bread and will increase the shel life of a properly made product by a day or more. In certain cakes, honey is added because it improves the browning quality and physical appearance of the final product. In stil other formulas the delicate honey flavor is retained to give the product a distinctive taste.

Slightly less than half of our honey is marketed as table grade. Usually it is blended, the most popular being the clover blend, followed by the slightly darker mixture of fall flowers. But relatively little of this honey is sold under its varietal name, one of the unfortunate aspects of modern-day marketing. For those people who are already aware of the many distinctive flavors and colors of honey available, there are specialty shops that cater to their tastes. Today an estimated two hundred types of honey are marketed under the names of their floral source. Hopefully, these "gourmet" honeys will encourage more people to become ardent devotees of man's oldest sweet.



The three large cells in this comb are royal cells, the residences of queen larvae. Below, two queens fight to the death, since each hive can have only one. The old queen often fails to survive such struggles with her newly emerged daughters.

Overseas Nature Tours

For eight years we have been organizing group trips to investigate the natural history of Europe, Africa and the world. See summary of world program in opposite column. Below are details of groups now forming:

— SOUTH AMERICA —

Feature for the Fall of 1969 is a series of 3-week tours circling South America, starting Aug. 17 in Colombia and swinging counter-clockwise around the continent. We'll go as far south as Tierra del Fuego, touch all the famous bird observation highlights of the Andes and both coasts, and end in Venezuela before Xmas. See dates in opposite column, and let us send you the itineraries.

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Our extraordinary 1969 coverage of Europe in eleven separate tours is by far the broadest view of this continent's natural history and off-route scenery ever offered. Take single excursion trips for economy, or combine tours to produce the route of your own choice. Our "Europe 1969" folder shows you how. All under top ornithological and botanical leadership, of course. Each tour, 3 weeks.

EUROPE SOUTH covers France's Camargue and Riviera, Switzerland's birds and alpine flora, famed Neusiedlersee on the Hungary border, and the Rhine country; May 8. **EUROPE NORTH** takes in northern Germany and covers Sweden fully to and beyond the Arctic Circle; May 29. **NORWAY**, our most popular of all, covers fjords, mountains and coastal islands in an itinerary that has become famous; June 22. These 3 tours combine into a memorable journey "north with the spring" from the Mediterranean to North Cape and the Arctic.

MEDITERRANEAN begins at Lisbon, visits Spain's famed Coto Doñana, France's Camargue, Corsica and northern Italy; May 8. **BALKANS** starts at Venice, visiting bird and botanical highlights of Yugoslavia, Greece, Turkey, Romania and Hungary; May 29. **U.S.S.R.** starts from Prague June 22, covers natural history highlights of Poland and Russia. **SIBERIA** is a 3-wk. link in an economical round-the-world route; the Asian U.S.S.R. republics, Lake Baikal and a journey into Outer Mongolia are features; July 13. These 4 tours combine into an extraordinary nature experience.

BRITAIN, leaving May 29, is a popular broad coverage from southeast coast to north tip of Scotland. **ICELAND**, 2-week visit to this weird country, offers a choice of departures (June 28 or July 21), with a new 10-day camping trip across little-visited centre and east coast areas available between the tours, and a visit to Greenland optional at the end.

COMING IN 1970: A thrilling series in Asia starts in January with **HIMALAYAS, INDIA-CEYLON, THAILAND-CAMBODIA** and **MALAYSIA**—four connecting 3-week trips. A remarkable coverage of South Asian birds and wildflowers, combining into a memorable round-the-world experience stretching between Christmas and Easter.

CROWDER NATURE TOURS
Box 222-a
Harpers Ferry, W. Va. 25425

Round Trip with the Salmon

Continued from page 50

pears, fully developed, during the summer and spawns in the same year.

When the fish enter fresh water they are in prime condition, their bodies are fat and oily, muscles taut, eyes keen. They do not feed; the energy they stored up in the ocean is sufficient. Their schedule is fairly rigorous and their strength adjusted to the ordeal that lies ahead. If their return is delayed too long they will die without reproducing.

During the upstream migration, the dissolved oxygen in the water sustains the fish and impels them to forge ahead. If the oxygen level drops too low, as it does in summer on such polluted rivers as the Willamette in Oregon, the salmon are immobilized. Also, if the waters are overheated, as in the Snake River in summer, the salmon may die.

To follow salmon upstream is an exciting experience. Their advance is a staccato series of stops and starts, overcoming one obstacle after another, and maintaining enough speed to prevent the river from carrying them back down. They push forward until, exhausted, they seek a quiet pool where they can lie behind rocks or in the shade of trees. Adults move both day and night, especially in the early morning when the light is dim and the water murky.

Meanwhile, their strength declines, their bodies become emaciated, their stomachs shrink. Consider the hardy travelers who move up the Amur, the longest river in the Soviet Far East, which flows out of the highlands of Mongolia and empties into the Tartar Strait. The fat content of the males drops from 9.2 percent when they enter fresh water to 8.2 percent at 240 miles; 5.7 percent at 340 miles; and 3.4 percent at 715 miles. The females use up even more energy; their fat content declines from 11.3 percent at the river's mouth to only 3.0 percent at mile 715. Many of these long-distance travelers reach the spawning grounds mangled by predators, with battered bodies and skin discolored by fungus.

The size of the runs may vary considerably, but each is usually directed towards specific spawning areas in the watershed. It is likely, as Roderick Haig-Brown says, that "most such runs developed behind the retreating ice [of the Pleistocene] and represent differences in t
reserves of energy within the fi
themselves on leaving salt wat
those stocks with the greatest
serves pushing on to more and mo
remote spawning areas as the i
withdrew." On the Columbia, f
instance, spring-run chinook pa
through the offshore fishing groun
or go over the dams, mainly in Ap
and May. Early in June they can
seen in deep holes near the upp
spawning areas, but they do not dr
their eggs until August or later, wh
the chill of autumn is in the air. Th
have been in the river up to s
months. For comparison, fall-ru
chinook appear in August and Se
tember; sockeye in June and Jul
coho from August through Decen
ber; and chum, which are not n
merous, in October and Novembe
Steelhead run the year round in th
Columbia River watershed b
mostly in winter.

Before North America's large
dam, Grand Coulee, was built in th
1930's, chinook and blueback worke
their way up the Columbia into C
nadian headwaters more than 1.00
miles from the sea. The dam blocke
all fish migration and cut off 1,20
lineal miles of spawning gravels.

Salmon in the Amur, Pechora, an
Yukon rivers now set the world
records for inland navigation. Th
Yukon originates near Fort Selkir
in Yukon Territory, flows past Daw
son, the derelict city left by the Klon
dike gold rush, turns northwest an
enters the state of Alaska, then con
tinues in a west-southwest directio
across the state to empty in the Ber
ing Sea. Five salmon species dwell i
the river, but chinook (there calle
king), coho, and chum are mos
abundant. Some chinook traverse a
most the entire Yukon to mate in Ne
sutlin Lake in Canada, a distance o
nearly 2,000 miles, while chum an
coho spawn in Tesline Lake, 1,73
miles from the ocean. The only know
run of chum making a comparabl
nuptial journey is in the Amur.

Almost as soon as the Yukon i
clear of ice, late in May or earl
June, the chinook appear, hitting
steady pace of 10 to 20 miles a day a
first but stepping up speed in th
higher waters. An old study by th
U.S. Bureau of Fisheries showed tha
by the time they reached Whiske

ek, 622 miles from the sea, they recorded 52 miles per day; at ana, 804 miles, 60 miles per day; ish Creek above Rampart Rapids ere the U.S. Army Corps of En-eers proposes to build the world's est hydroelectric dam), 851 miles, miles per day; at Circle, 1.227 es, 47 miles per day; and at Eagle, 2 miles, 50 miles per day. When y arrived at Dawson, 1,500 miles m the sea. they had been moving inst a consistently rapid current 29 days at the rate of 52 miles day—and had not eaten a morsel! ey contain no more oil than is ded to furnish satisfactory dog d," said the observer. In contrast, en the gleaming silvery coppery came into the river they were too to be canned.

Chum enter the Yukon a week later n the chinook, and their move-nts are almost as rapid. At Ta-a, it was found they were but 10 s behind, and at Dawson City y 14 days behind the larger spe-s. Chum covered the lower 800 es, as far as Tanana, at an aver- speed of 90 miles per day, and next 700 miles, between Tanana Dawson, at 55 miles per day. ese migratory feats in a fast-flow- river are probably unique among shwater fishes of the world.

When they finally reach their me waters, the salmon prepare for supreme act of their lives. Each nale, shunting the male aside, com-nces to dig the redd. Poised at an gle of 45 degrees to the current, ad facing upstream, she violently xes her tail, and turning her body m side to side, scoops out the avel and silt that the boiling cur-t moves downstream. After much vail, her redd, a long oval about ice the length of the salmon and veral inches deep, is ready for her ng-in, so to speak.

Now the males begin to hover ound. Each time the female re-ses eggs a male moves quickly ongside her and curves his body ainst hers. His sperm is released in small, silky cloud. The eggs are thus rrounded by sperm and eventually rtilized. Each female of the Pacific mily produces from 2,000 to 6,000 gs, the number depending on the ecies and size of the fish.

After spawning, the female is unt and spent but continues to dig the gravel with ever weakening efforts until she dies. This post-spawning digging, which may continue for ten days, becomes shallow, off center, and ineffective. Thus the area of the nest is increased without (after the first days at least) adding to protection of the eggs. Both male and female Pacific salmon will survive only a few days after dropping their milt and roe.

For a specific vignette of the salmon's return, let us journey to the Kvichak River system, a major contributor to Alaska's Bristol Bay runs. It includes Iliamna Lake, 80 miles long and 20 miles wide, and Clark Lake. 50 miles long and 4 miles wide. In 1960, when 14½ million sockeye poured into the Kvichak, 9 million passed into Iliamna Lake in a period of nine days, the largest run ever recorded there. The 1965 run totaled 25 million fish.

The small, scarlet fish with olive heads move in close formation along the shores and out toward the middle of the stream, forming a band several miles long. It is July; the air is brisk; the summer sky is blue and cloudless; and the pale-green, shallow water flows at a gentle pace. The terrain is flat, with low shrubs along the banks, and in the distance one can see towering, snow-capped mountains. Human habitations are few, for this is wilderness. Indian women may be seen fishing from the banks, others are filleting salmon. Fish are drying on numerous racks.

The hordes of sockeye swim upstream in magisterial spendor. Although there are other species in the river, reds travel with reds, and no others. Ranks break up as fish pair off. Frantic females are digging cribs in the gravel, while the nervous males hover nearby, fighting off all intruders. The lake's tributaries teem with fish eager to drop their roe and milt, for they do not have much time. Millions are mating and dying together.

After several days the orgy of reproduction is over. The river and lakes are littered with spent, discolored fish. The carcasses of others, bleached by the sun, are slowly rotting, washed by the cool waters. Families of bears are happily chewing on the salmon lying on the bank. The windrows of dead fish, extending 20 miles along Iliamna Lake, will decompose and fertilize the waters, so that other generations will find sustenance.

Overseas Nature Tours

— 1969 Program —

Here is a summary of our 1969 program. Space permits only brief mention of each tour, and one should, by all means, have the "Tour Catalog" with thumb-nail sketches of each trip. Early registration will save disappointment, and may be made tentatively. North America tours 2 wks., remainder of the world 3 weeks each, except as otherwise noted.

— NORTH AMERICA —

TEXAS BIRDS: Whooping cranes, Rio Grande reserves, Northeast Mexico. March 15.

TEXAS WILDFLOWERS: Separate wildflower group on above route. March 15.

ARIZONA: Popular bird tour of southeast Arizona under Dr. Robert Ohmart of University of Arizona. April 26.

CASCADES: North through Oregon and Washington reserves and parks. May 31 (3 weeks.)

ALASKA: Three successive 2-wk. trips: (1) The inside passage and Yukon; (2) the central region with McKinley Park, Kenai, Kodiak and Katmai; and (3) outposts of the Aleutians, Pribilofs, Nome, St. Lawrence . . . Island, Kotzebue and Point Barrow. Series begins at Seattle June 21.

— MIDDLE AMERICA —

PANAMA: Bird concentrations of Canal Zone & Panama mountains. March 1-15.

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— SOUTH AMERICA —

COLOMBIA: World's top bird country. Two 1969 departures: March 15; Aug. 16.

ECUADOR-PERU: Heavy bird populations of jungles & high Andes, including Machu Picchu and upper Amazon. Sept. 6.

CHILE-ARGENTINA: Highlights of both coasts, plus Tierra del Fuego. Sept. 27.

BRAZIL: Iguasu Falls, the Rio coast, central jungles and the Amazon. Oct. 18.

GUIANAS-VENEZUELA: The 3 Guianas, Trinidad and highlights of Venezuela. Nov. 8.

The 5 South America tours, starting with Colombia on Aug. 16, readily combine into a remarkable grand tour of the continent.

— EUROPE —

By all means obtain the detailed announcement of our 11-tour 1969 Europe program, with its many possible combinations. See opposite column for additional information.

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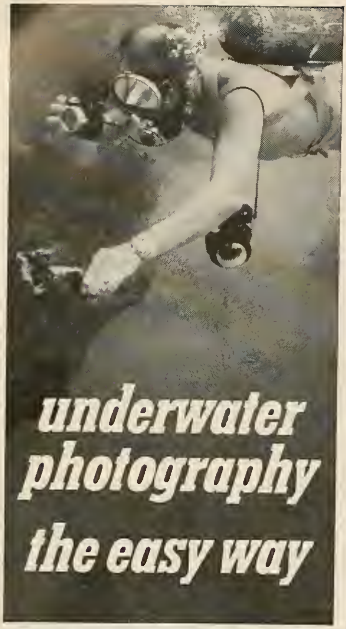

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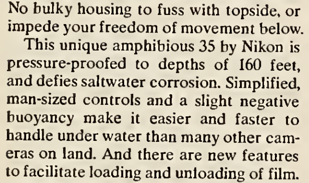
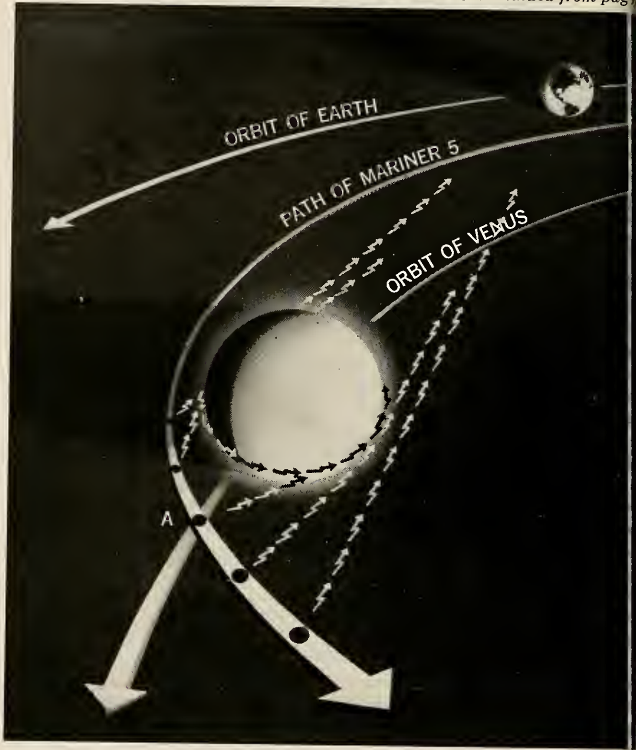


NIKONOS II
by Nikon

Venus, Star of Sweet Confidences

Continued from pag



Radio signals from the Mariner 5 spacecraft were bent from a straight path by the dense Venusian atmosphere as the craft approached that planet. Signals emitted behind Venus (point A) never reached earth. They were refracted by the lower and denser atmosphere, and traveled in a circular path around the planet.

vide an answer to the first question. The dense atmosphere of carbon dioxide acts as an insulating blanket, which seals in the planet's heat and prevents it from escaping into space. The trapped heat raises the surface temperature far higher than it would be otherwise. The mechanics of this effect can best be understood by using the earth as a model.

Solar radiation reaches the earth at a rate of two calories per square centimeter per minute. Part of this energy (about 30 percent) is directly reflected back into space by the planet's clouds. About 70 percent of the solar energy penetrates throu the atmosphere and reaches the s face. This energy is sufficient to h the ground to a temperature of o −30° F. At this temperature, eart surface radiates energy only in t far infrared region of the spectru The atmosphere, however, contai small quantities of water vapor, c bon dioxide, and ozone. These gas although transparent to the solar r diation in the *visible* spectrum, ha the property of absorbing *infrar* radiation with great efficiency. T energy thus absorbed by the atm phere then radiates in all directio partly toward the earth's surface a partly outward into space. The ra ation toward the surface increas the ground temperature from −3 F. to the normally observed value 60° F. This phenomenon is called t "greenhouse effect," wherein our mosphere acts as a glass cover, tran parent to solar radiation enteri from above but opaque to the trapp radiation below.

Calculations based on the insula ing properties of a heavy layer

bon dioxide show that the tem-
ature of Venus could easily rise
300° F. as a result of the green-
ise effect. This being the case, the
stion that one then asks is why
bon dioxide is so abundant on
nus and not on the earth? In this
nection it is interesting to note
t the amount of carbon dioxide
Venus—as measured by the space-
ft experiments—is, within a factor
two or three, about the same
he amount of this gas that is today
ked up in the earth's surface in
form of carbonates such as lime-
ne. Slowly, during the history of
earth, the carbon dioxide in the
nosphere reacted with calcium and
gnesium silicates found in rocks
form carbonates that now lie
ried in the crust. For this reaction
proceed rapidly two important
tors are necessary: moderate at-
spheric temperatures and the pres-
ce of liquid water. When the sur-
e temperature is high and liquid
ter completely absent, as on Ve-
s, this reaction becomes ineffec-
e in removing carbon dioxide from
atmosphere, and the pressure
m this gas builds up to very high
lues, as observed on Venus—an at-
spheric pressure of 1,500 pounds
r square inch.

But, then, why is water scarce on
nus? The most probable explana-
n is that solar ultraviolet radiation
s extensively dissociated Venus's
ter molecules into hydrogen and
ygen during the planet's history.
ydrogen, which is too light a gas
be held by the gravitational field
the planet, has escaped. The same
ocess of dissociation and escape
s occurred on the earth, but at a
uch lower rate owing to three spe-
al circumstances.

First, the average temperature of
e earth's surface is only 60° F.;
erefore water stays mainly in liquid
rm (in the oceans) and only a
ry small fraction of the total water
part in 80,000) is in the atmos-
here, in the form of water vapor.
order to be dissociated into hydro-
en and oxygen by the solar ultra-
olet radiation, this water must rise
rough the atmosphere to its upper
dge (an altitude of about 80 km.),
here it can be exposed to solar ul-
aviolet radiation. (This part of the
n's radiation does not penetrate
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olecules of oxygen and ozone ab-

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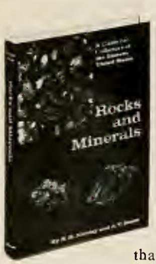

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sorb it high in the atmosphere.) But as the water vapor rises, 99.9 percent of it is condensed out to form clouds before it gets to the altitude of 15 km. It then falls back to the ground as rain. The temperature of the earth's atmosphere decreases sharply with altitude; at 15 km. (a level known as the "tropopause") it reaches a minimum of about −110° F. The colder the air, the less water vapor it can hold, and any excess amount immediately condenses out as drops of water or ice crystals. Because of this "cold trap" in the atmosphere, only an extremely minute amount of water vapor ever rises to the height where it could be lost by dissociation. This is the second special circumstance that has inhibited the loss of oceans from the earth.

The third factor limiting water loss is the abundant presence of free oxygen in the atmosphere of the earth. As mentioned above, this gas absorbs the lethal ultraviolet rays and prevents them from penetrating to the lower levels of the atmosphere and to earth's surface. If it were not for this oxygen, the cold trap effect would be ineffective in limiting dissociation because the solar ultraviolet would break up the water molecules near the earth's surface.

None of these three circumstances seem to exist on Venus. To begin with, Venus's surface temperature is so high that all its oceans should be in the form of water vapor. Then, the Venusian cold trap is not as efficient as earth's. The tropopause temperature on Venus, as measured by Mariner 5, is a relatively warm −30° F., thus allowing about 1,000 times more water vapor to leak through to the upper atmosphere than on earth. Finally, the protective oxygen layer seems to be missing. Under these conditions, according to a recent calculation, the rate of dissociation of water and the subsequent escape of hydrogen into space is so rapid that Venus could be losing about a million tons of water every day. This is approximately the rate at which water is being added to our oceans by hot springs, geysers, and volcanoes, which bring water up from the earth's interior. In the last 4.5 billion years, enough water has accumulated from inside the earth to form our oceans. On Venus, it would appear that instead of accumulating, the water is dissociated and lost into space. The small amount water that is now observed in t Venusian atmosphere (0.1 percen may merely be in transit between t ground and the outer fringes of t atmosphere.

There is, however, an appare fallacy in our arguments regardi the escape of water from Venus. Fo as a direct consequence of the brea ing down of water into hydrogen a oxygen, and the subsequent esca of hydrogen into space, a lar amount of oxygen should remain b hind in the atmosphere of Venu Why then do we observe it in su small quantities (less than 0.01 pe cent of the atmosphere) on the su face of Venus?

In this regard Carl Sagan, now Cornell University, suggested a fe years ago that at the high temper ture of Venus, the lower atmosphe should contain substantial amoun of gases such as carbon monoxi and methane. These gases, howeve have not been detected in significa quantities. The reason may be th the free oxygen, released by t photodissociation of water vapor the upper atmosphere, oxidizes the gases rapidly to form carbon dio ide. At high temperatures this rea tion proceeds rapidly and free ox gen is used up as soon as it is forme Also, as in the case of the earth, V nus may contain large amounts ferrous iron in its crust. If this the case, any free oxygen produce in the atmosphere will be immed ately taken up by the iron to becom ferric oxide—rust. This is the sam process by which the interior of a apple (which contains iron) become rusty brown when exposed to the ai All the oxygen of the Venusia oceans is probably today lying locke up in the rusty surface of the plane

The scarcity of water and oxyge and the abundance of carbon dio ide in the atmosphere resulting i extremely high surface tempera tures, are all consequences of Venus formation slightly closer to the su than the earth. At the time of the birth, it seems likely that the earth temperature was in the neighborhoo of 50° F. and Venus's was abou 120° F. The difference in initial te perature was enough to cause t two planets to follow entirely diffe ent paths of evolution. One develo ed into a prolific haven for life, t other into a sterile, lifeless inferno.

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and her people are fighting r kind of war. This time the s are poverty, disease and . And for the first time in gen- s, there's a chance that the es might win: thanks to the eous efforts of her own people ther Americans like the ns.

ne and Stan Winston and wo daughters live in a New uburb 2,000 miles from the ation. But it's another world. instons live in a big, old house mplain about a big, new mort- Their girls have a closetful of and "nothing to wear." They ikes, skates, games, books, rec- d "nothing to do."

lla and her seven brothers ters have none of these prob- Her father spends as much time looking for work as he does working. Sanitary facilities are almost non-existent. Electricity has yet to reach them. Water is hauled by hand. Even the necessities are hard to come by.

rough Save The Children Fed- , the Winstons are helping The cost is $15.00 a month. a lot of money, but certainly nstons could have thought of f other things to do with it. ately they thought of Della

her, these funds make a re- ble difference. She no longer eel embarrassed about not hav- oes, a decent school dress, supplies, or pocket money.

me of the pressure, too, is off arents, who can now begin g about making their home a ore livable. Also, and perhaps mportant, part of the money into a fund from which the can borrow to start self-help

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past 10,000 years and to delineate th
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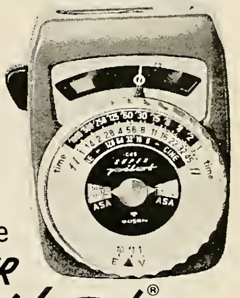

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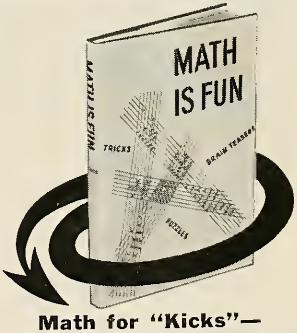

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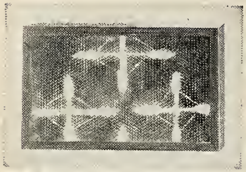

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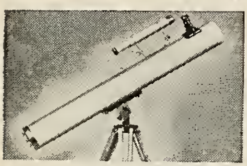

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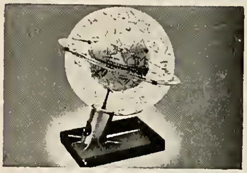

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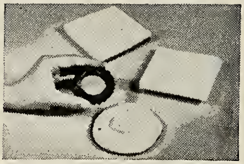

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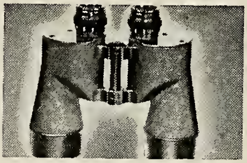

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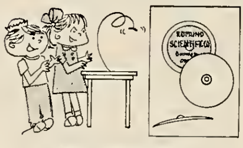

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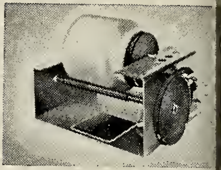

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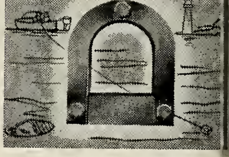

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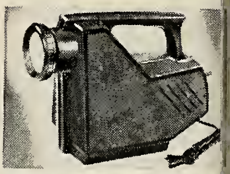

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:es appropriate change in social
zation and ideology. Human his-
n the broadest sense, is a specific
of "technological revolutions,"
sponsoring one or more major
zational processes" that create
ponding "sociocultural forma-
' The varieties of such formations
termined by, among other things,
ıal differences in ecological op-
ıity and constraint. Thus, for in-
:, the industrial revolution yielded
the western European industrial
ıtion process, which has produced
esent day sociocultural formation
: imperialistic industrial powers
the United States) and their as-
ted neocolonial dependencies
Brazil), and also the process of
listic expansion, which has pro-
l three sociocultural formations—
socialistic revolutionary nations
the USSR and China), the so-
tic evolutionary nations (e.g.,
en), and the nationalistic mod-
ing states (e.g., Egypt, Algeria,
Cuba). But Ribeiro's system is
lex enough to include both peri-
of decline (often into feudalism,
h he does not regard as an evolu-
ry stage but as a regressive condi-
into which almost any civilization
fall) and of revitalization (which
:es as being frequently prompted
esistance to class or colonial ex-
ation). He recognizes that socie-
nay participate in the civilizational
ess both on their own innovative
ıtive ("evolutionary acceleration")
also as a result of diffusion and ac-
ıration in a colonial situation
storical incorporation"). The re-
of this mode of analysis is both a
itional evolutionary ladder, begin-
; with the agricultural revolution
culminating in today's incipient
monuclear revolution, and also an
ysis of types of societies and their
tionships. Perhaps his most tren-
nt observations concern the relation
veen the contemporary capitalist in-
trial powers and the so-called un-
leveloped nations. He emphasizes
the underdeveloped nations are
simply backward societies that
e not yet reached the industrial era;
ıer, they are products of the indus-
l revolution, essential in their pres-
form to the capitalist industrial
vers, which they serve as sources of
materials and cheap labor (the
ternal proletariat"). Far from being
cs of a preindustrial past, they are
ispensable, even if unfortunate,
nual labor specialists in the world
ustrial system.

The need to review all of man's his-
y beyond the Stone Age in one hun-
d and fifty pages of text requires of
eiro a level of generalization that
kes most factual criticism inappropriate; the grand sequences he describes are valid even if some of the details may be argued. Nor does the mildly socialist jargon seriously impede the communication of concepts and knowledge shared by most educated men. Ribeiro's scheme stands with those of Lewis Henry Morgan and V. Gordon Childe as a truly substantial summary of the main events in history.

There are, however, some serious difficulties in the aspects of the work that go beyond the descriptive level. The difficulties have to do with the criteria of historical explanation (and of futuristic prediction) and are of two kinds: avoidance of any systematic "functional" analysis of cultural systems and failure to ask serious questions about the nature of human nature. It is the general assumption of functional analysis that customs persist not merely because they are useful to somebody (such as an exploiting ruling class) but because they contribute to the integrity of the whole social and cultural system. The question then is: what are the actual functions of a custom or institution? Ribeiro asks this question only irregularly. Thus, for example, in discussing the ancient theocratic irrigation empires—particularly Egypt—he repeatedly disparages the priestly class as "parasitic," "expensive," "bureaucratic," and the like; he does not emphasize the importance of calendrical knowledge, and other forms of technical expertise, to the coordination of agricultural production, although he concedes the desirability of having an educated, as compared with an uneducated, bureaucratic civil service to manage the labor force. This reluctance to ask functional questions systematically sometimes leaves the explanation of social, let alone ideological, change at almost a "goodies and baddies" level. Vast abstractions collide: "despotism," for instance, interacts with "organic solidarity" again and again to yield "decadence." But the abstractions are really people. Good people are the oppressed; bad people are the oppressors. Good people are creative, productive workers; bad people are decadent, parasitic exploiters. And so forth and so on. History tends almost to become an endless series of Italian gladiator movies and Hollywood Bible epics.

Related to the lack of interest in fine-grained functional analysis is a certain casualness in the assumptions about human nature. The goodies seem to be inspired mainly by aspirations for material comfort and ethnic or national liberation; the baddies, by greed and the lust for power. Occasionally, whole civilizations are lifted above these protean motivations by a sense of mission. But there is little concern with the in-

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tricacies of human psychology; and hence, again, the search for explanation is diverted by dependence on value stereotypes. Thus the recurrence of despotism is explained as a consequence of social processes (bureaucratic deterioration, militarism, etc.), which have no necessary relevance to the dominance-submission propensities of primates. And thus the State of Israel is classed with white South Africa as an example of an intrusive "caucasoid" settlement in a "foreign" environment, doomed to extrusion; the motivations of the Zionists in choosing Palestine do not seem to be relevant because Israel is interpreted as an outpost of the imperialistic industrial powers rather than as an oppressed ethnic minority seeking liberation.

These limitations become acute in the final pages of the book where the contemporary world is analyzed and the future of human society adumbrated. Ribeiro sees the future of the world as a universal sociocultural formation, characterized by a union of electronic and nuclear technology with a socialist form of social organization and an ideology of potentiality-liberating freedom and social responsibility. Although he recognizes the danger of despotism, and notes the resurgence of classes in socialist countries, he looks forward to the paradoxical Marcusian utopia of psychological freedom in a situation of extreme social control. One has the feeling that in his admiration for revolutionary socialism Ribeiro has missed identifying one of the sociocultural formations characteristic of the modern era (although it is now as outmoded as old-fashioned capitalism): the salvationist totalitarian socialist empire—a category that would include not only regimes of the Stalinist and Maoist type but also such aberrant national socialisms as Hitler's. But nonetheless, although Ribeiro is not explicit on the point, one also has the feeling that, as many Marxists do—and for the same reason as anti-Marxists—he recognizes the current wave of antibureaucratic protests among students and minority populations in all industrial countries as being less a part of the class struggle than a generic challenge to that bureaucratic way of life common to all forms of the industrial state. The change in social organization and in ideology associated with the new technology will then, hopefully, be a radical change in the nature of bureaucratic systems, whether capitalist or socialist, rather than a victory of bureaucratic socialism or bureaucratic capitalism.

Dr. Anthony F.C. Wallace is Chairman of the Department of Anthropology at the University of Pennsylvania.

WILDLIFE IN DANGER, by James Fis
Noel Simon, and Jack Vincent.
Viking Press, Inc., $12.95; 368 pp.,
lus.

This book is an effort on the par
the Survival Service Commissio
the International Union for the C
servation of Nature and Natural
sources (IUCN) to make genera
available to the public the informat
now contained in IUCN's *Red D*
Book, a loose-leaf, ever-changing
count of the world's rare and end
gered species of wildlife. IUCN a
The Viking Press have succeeded
putting together a handsome volu
beautifully illustrated with line dra
ings and paintings, that gives an
count of the current status and rec
history of each of the species of ma
mals, birds, reptiles, amphibians, a
fishes now known to be in danger of
tinction.

This is a factual account of the w
things stand today, a reference bo
not an alarmist or emotional appe
Perhaps just because of this, it is m
shocking. Today, at least 120 spec
of mammals are in some danger of
tinction, and at least 187 species
birds are in a similar state. In additi
223 races or subspecies of mammals a
endangered along with 287 races
birds. The situation among repti
amphibians, and fishes is not as w
known—indeed many species may w
become extinct before they have be
discovered and described. Plants a
also treated briefly in this book, but
are quite ignorant of the current stat
of most plant species. Invertebrate a
mals are not covered, and one could n
even guess how many species could
added if they were. As the introducto
sections of *Wildlife in Danger* ma
clear, the entire web of life on o
planet is being torn and shattered
our technological civilization at a ra
that has never been equaled in previo
times.

I suppose the key question raised
this volume is whether or not peop
really care that so many of their fell
creatures on planet earth are passi
forever from existence. Judging fro
the membership in conservation
ganizations, one could answer po
tively that many do care. But judgi
from the financial support provided
those organizations that are trying,
an international scale, to prevent e
tinctions from taking place, one wou
have to answer negatively. IUCN is
self in danger of fading from the sce
for lack of financial support. It has on
continued to exist through the dedic
tion of some hundreds of people w
have worked without pay over the yea
to keep it alive. It has been unable
launch the programs that would

y effective in halting the processes xtinction described in this book. ne subspecies listed can now be re- ed and placed in the black book. Mexican grizzly bear, according to cent survey by Starker Leopold and l Koford, has not been recorded in last hiding place in Mexico since 2. Ten years ago, an expenditure of w thousand dollars could have kept Mexican grizzly alive. The money ld not be found. Now, apparently, lions cannot bring it back. There is ing so final as extinction.

or many species the situation is also eless, not because they cannot be d but because, unless there is some at change of attitude among our ple, the money needed for the job l not be found.

ortunately the record is not entirely couraging. For other species—the thern sea otter, trumpeter swan, and rida key deer among them—recov- under protection has been excellent l the imminent danger of extinction been removed. But to balance this re are dozens of species and races, hin the United States alone that st soon be added to the list, if our rent practices involving the use of ticides are continued.

would strongly urge that you buy l study this book if for no other rea- than the revenue that will accrue IUCN from its sale. Apart from that s a beautiful and necessary addition any wildlife library.

Raymond F. Dasmann
The Conservation Foundation

ERNAL QUESTS: THE STORY OF THE EAT NATURALISTS, by Alexander B. lams. *G.P. Putnam's Sons, $10.95; 9 pp., illus.*

nyone who writes a book reveals a great deal about the personal val- s that compel an author: the enthusi- ms, the tolerance, the honing of oughts until the words expressing em are sharp with communication. e reader can ignore these revelations d concentrate upon the story. But ter the last page is turned, he may ok back to see why the book was ritten.

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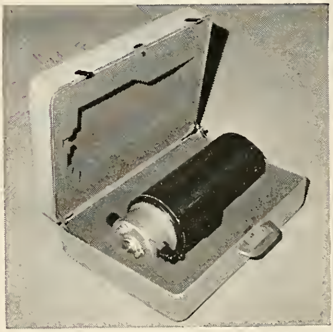

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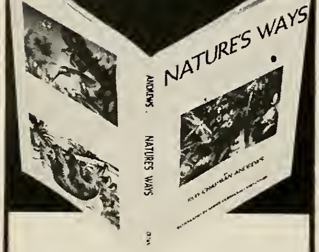

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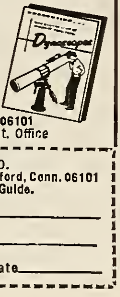

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and to the nineteenth by page 148. The twentieth century, now more than two-thirds over, earns less than a page. It is between 1700 and 1900 that the author feels at home and sees naturalists concerned with the whole of nature. Clearly, and with many a quotation from their own words, he brings out their contributions to scientific understanding and lets the reader appreciate the joy each man found in the natural world.

No one will quarrel with Adams' choice of the greatest naturalists: Carl Linnaeus, George Louis Buffon, Jean Lamarck, George Cuvier, Alexander Wilson, John James Audubon, Alexander von Humboldt, Charles Lyell, Louis Agassiz, Charles Darwin, Alfred Wallace, Thomas Huxley, Gregor Mendel—except perhaps Mendel, whose one great scientific "expedition . . . took him no farther than a tiny patch of soil behind the wall of the monastery's library." Important as Mendel's experiments and conclusions proved, we would trade him off as a naturalist for his contemporary, Jean Henri Fabre, who goes unmentioned in *Eternal Quest*.

Generously informative, the book provides a pleasant history of biology and geology, with occasional excursions into medicine and astronomy to point out parallels in scientific progress and the way in which new ideas echoed back to increase appreciation for the living world. Yet the account brings out the personality of each of the principal characters—his aims, his experiences, his conclusions, his foibles, his interaction with others of his time. Making naturalists live again, as comprehensible human beings, is the author's greatest skill—one he demonstrated before in his fine biographical books *Thoreau's Guide to Cape Cod* and *John James Audubon: A Biography*. His new work fills in the background and shows that the tradition of the naturalists goes far back.

In our modern context, we cannot overlook the fact that the author has chosen only white men as great naturalists—no women, Negroes, or Orientals. Cultures other than Western are passed by without comment. So are all the Russians and other Slavic peoples. There is nature in Asia, Africa, and Australia, as well as in Europe and the Americas. Some of the explorers were fine naturalists, and their tradition continues today on these other continents. Readers should know about them too.

The twentieth century seems a greater gap in *Eternal Quest* for it is the century of ecology, of despoliation, of conservancy. Not every man has become a specialist to the exclusion of an awareness for nature. More people than ever before are seeking a wil ness vacation, and insisting that na plants and animals be left a place. need to appreciate the modern natu ists who are outspoken leaders, an see their effect in the best perspec possible. Alexander B. Adams is id ly located to gain that perspective, the man to write the sequel to his standing present book.

Lorus and Margery M
University of New Hamps

A NATURALISTIC VIEW OF MAN, George Crile, Jr. *The World Publ ing Co., $4.95; 177 pp.*

Dr. Crile, a specialist in ca research, has been captivated the field of animal behavior—a resul acquiring a number of wild animal pets. The doctor has worthy asp tions; he sees in the study of ani behavior a source of hope for the vation of man. References to the searches in the field are sprink throughout his chapters, which d with aspects of instinct, mem learning, emotions, sex, and social Unfortunately, he doesn't underst the field of behavior, neither human animal. On the one hand, Dr. C stresses that our behavioral devel ment is immutable, coded in the ge at the instant of fertilization; on other, he talks about the plasticity man's behavior, his capacities, and strong modifying influences of envir mental conditions. His concern w the concept of instinct reveals naiveté of a field that has taken lo strides away from the severe li tations imposed by this concept. printing (which, for some reason, awkwardly refers to as imprintatio has also caught his fancy. It fits bea fully into his notion of a specific ti of exposure to specific stimuli. Inde he implies that if an experience d not occur during a certain time. possibility of having it is lost forev The author believes imprinting allo us to become social beings. Such ut nonsense! Imprinting as studied in a mal behavior has specific and rath rigid qualities. Stretching it to hum behavioral development is a disservi to the understanding of man's beh ior. Dr. Crile has not scrutinized t relevance of his facts when he sees havioral homology in a wood duck ciety and a gang of boys. For examp he treats a case of kleptomania, t stealing of a large number of neckt by a boy at school, as the hoardi instinct in man. There is no relevan He sees behavioral development trial and error learning, reinforc by memories of reward and punis ment. What erroneous simplicity. refers to the failure of having

-mal environment as deeply affect-
; emotional behavior in later life. But
ıy tell, Dr. Crile, what is a normal
/ironment for man? There is talk of
ial heritage and racial learning and
mory capacities are stretched to in-
ıde bacteria. In learning, Dr. Crile
lieves that bright children who learn
ster, forget faster. Not true at all. For
: proper development of socializa-
n, Dr. Crile believes that children
ould be raised only with peers, such
on a kibbutz, and that parents
ould throw their children out before
ey are old enough to rebel and leave
me on their own accord. Somehow he
oids referring to the importance of
ection in the development of social-
ıtion.

Dr. Crile comes into his own when
treats medical subjects, especially
ıen decrying faddism, opportunism,
d dishonesty in medical practice. He
ites a succinct critique of his book
the following sentence, "One of the
oblems in the treatment of disease is
at the physician is not primarily a
ientist. He is a practitioner." Would
at Dr. Crile were at least a practi-
ıner of behavior. Unfortunately he
not, and the book suffers from a
vere anemia of sound behavioral
inciples.

EVELYN SHAW
The American Museum

ANDS BEYOND THE FOREST, by Paul B.
ears. *Prentice-Hall, Inc., $7.95; 206*
., illus.

t has been many years and many
books since *Deserts on the March,*
ıd this latest volume from botanist-
ologist Paul Sears is a logical devel-
oment in his offerings to the nature-
inded public. As Joseph Wood
rutch says of the author in the Intro-
ıction, "He has for open spaces a feel-
ıg of personal involvement, which no
ıan who was merely an observer could
ossess."

The relict prairies of northern Ohio
a fire-maintained vegetation domi-
ated by tall grasses and brightly flow-
red forbs—first charmed the boyhood
iterest of Sears in "lands beyond the
rest." Subsequently he extended his
udies westward to the true climatic
rairies, the high plains, and deserts,
nd on around the world through
ampa, steppe, veldt, and tundra. His
urview admits no limits as he tells
asually and convincingly of the emer-
ence of forest-dwelling man into the
avannas and open country, where rich
esources in prey and large-seeded
rasses opened the way to civilized
eisure and a higher culture. Through
he cultivation and improvement of
ereal grains man became an agricul-
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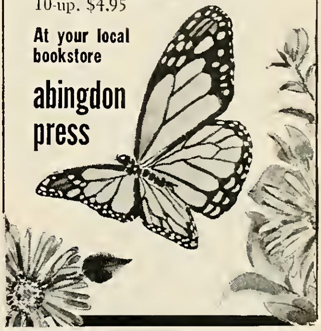

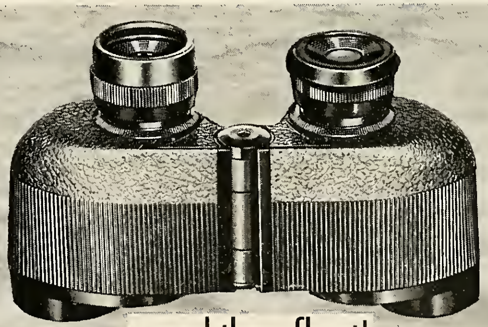

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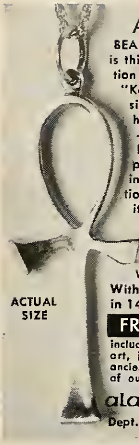

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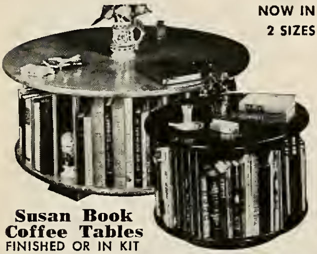

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ported by his domesticated livestock, he lived in the grasslands as a nomad, or scourged the spreading brushlands with sheep and goats. In this book the human involvement with living things is featured through classic allusion, archeological fact, and biological realism.

As might be expected of an expert on prehistoric pollens, Sears relates grasslands and deserts to their geologic origins—especially through land uplifts and changing climates, glaciation, and the desiccation of trapped waters. Plants and animals show adaptations for water conservation that are increasingly effective from the subhumid prairies to the dry plains. Latitudinally, the ratio of anual rates of evaporation to precipitation are important in limiting life communities. Being the primary support of grazing animals, the grasses sustain without damage the clipping of their leaves. The seedlike fruit is a package of nutriment, and fibrous roots bind soil against wind and water. Composites and legumes also are especially important in the swards of open lands.

Natural vegetation adapts regionally to recurring periods of water scarcity, while wheat, "product of a remote region and long nurtured by man," does not. The resulting chaos of dust storms and disaster is "an unforgettable reminder that greedy and ignorant tampering with the landscape can be as dangerous as taking careless liberties with a cobra or high-tension wire." The author seldom fails to extend his logic to the human problem. After describing the cycling of lemmings he remarks: "After prolonged and specious debate in which visionaries proclaimed the unlimited capacity of science to care for unlimited numbers it is now conceded that the population of human beings, like that of all other organisms, must be brought into some kind of balance with reality."

Sears deals thoughtfully with our disappearing wetlands and describes with particular concern the ecological disruption of the Florida Everglades. Natural vegetation, he asserts, is our guide to the best potential use of land. Wildlife effects of drainage have been far reaching, from conversion of the red-winged blackbird into an agricultural pest to the decline of seafood production along our coasts.

The book abounds in up-to-date summaries of man's dispersal over the earth, his tools, food collecting, and agricultural methods. It describes interesting facets of early cultures in centers of civilization in both Old and New Worlds. One chapter treats domesticated animals, from dog to elephant. Through deforestation by many methods in many areas, men have extended the natural openings, turning soil and vegetation to their use.

This is an enjoyable, informative, and easily read book that should be available to young citizens in school libraries. The price is too high for a small volume illustrated in sketches and offset photographs, although the format is pleasing and the manufacture of good quality.

Durward L. Allen
Purdue University

Affluence in Jeopardy, by Charles F. Park, Jr. *Freeman, Cooper and Co., $9.50; 368 pp., illus.*

In the second half of the twentieth century it appears as though civilized society is under assault from all sides. These confrontations include the traditional scourges of war and natural catastrophes such as floods and earthquakes. Seemingly more significant, however, is the depletion of natural resources and the growing inadequacy of the world's food supply together with a progressive devolution of our environment. There is also a rising tide of social unrest resulting in part from man's apparent ineffectiveness in dealing with these problems.

Affluence in Jeopardy is a book that puts these challenges to modern man in perspective. Professor Park presents, in a highly readable text for both the layman and the scientist, an account of the fundamental role that minerals, the most basic of man's natural resources, play in a modern society. The broad-ranging and well-documented facts clearly indicate that only finite quantities of these materials are available to man. The validity of a philosophy of worldwide material affluence, a basic corollary to Western civilization, is clearly brought into question.

Unless man accepts the fact that there are finite limits to the energy and other natural resources on earth available to him; unless his actions are appropriate to these facts; unless man stops trying to live beyond the earth's capacity for materially supporting him, his very survival, let alone existence in an affluent society, is in doubt.

The author succeeds in clarifying the imminent danger that exists. Only a few decades remain before the drastic consequences of final depletion of some natural resources would be felt. Professor Park also outlines some necessary actions, most important among which is the enlightenment and education of the public—a goal that this book will undoubtedly help achieve.

In criticism, there are some minor inaccuracies both in the numerical data and in the text, errors that should have been most carefully avoided in a book of this kind. The numerous illustrations of news clippings are in most cases not identified as regards

rce and in this reviewer's opinion
ract from the value of an otherwise
st commendable text.

D. VINCENT MANSON
The American Museum

iefly Noted:

E SCALE OF NATURE, by John Tyler
nner. *Harper & Row, $6.95; 171 pp.,*
s.
Going from the very largest objects
e universe, galaxies) to the very
allest (molecules, atoms), John
nner gives an over-all view of the
ences and of how the various
anches relate to each other. A por-
n of the book made up Dr. Bonner's
icle "The Size of Life," NATURAL
STORY, January, 1969. Patricia Col-
s supplied the 14 black-and-white
uatint etchings.

ILL SOULE: INDIAN PHOTOGRAPHER
FORT SILL, 1869-1874, by Russel E.
lous and Robert A. Weinstein. *The*
ard Ritchie Press, $12.50; 128 pp.,
us.
Will Soule was a 27-year-old Civil
ar veteran employed by the United
ates Army to photograph the build-
g of Fort Sill in Oklahoma. This
ve him the opportunity to photo-
aph a variety of Southern Plains
dians—Kiowas, Apaches, Cheyenne,
manches, and Arapahoes. The au-
ors, Belous and Weinstein, provide
ckground material on what is known
Will Soule and ethnographic mate-
al on the Indians, but it is the dra-
atic Indian portraits that are the crux
the book—men, women, and chil-
en in formal and informal poses.
hotographs of Indian encampments,
d one very graphic picture of the
ctim of a scalping, round out the col-
ction.

C.B.

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James H. Carmichael, Jr., Carrboro, North Carolina. Leica.

Mrs. Howard Crew, Iowa City, Iowa. Rolleiflex.

Robert H. Denison, Winnetka, Illinois. Linhof.

Marshall B. Drew, Westerly, Rhode Island. Leicaflex.

Robert L. Horstman, Longport, New Jersey. Nikon.

Wolfgang A. Mann, Arcadia. California. Rolleiflex.

August A. Sexauer. Cherry Hill, New Jersey. Nikon.

Richard M. Smith, Hastings-on-Hudson. New York. Miranda.

Fred H. Steiger, East Brunswick, New Jersey. Konica.

Honorable Mention

Dr. Harry D. Albert, New York, New York. Minolta.

Edward Bailey, Alexandria, Virginia. Hasselblad.

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Hall Blanchard. Jackson. Michigan. Leica.

Leroy Bond, Shawnee. Oklahoma. Kodak Retina.

Robert E. Bradley. Sunnyvale. California. Pentax.

Mrs. Elizabeth S. Burgess. Binghamton. New York. Rolleiflex.

Roger K. Burnard, Columbus, Ohio. Pentax.

Lawrence H. Butt, Oyster Bay, New York. Rolleiflex.

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Patrick L. Colin, Miami. Florida. Nikonos.

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Noel L. Dunn, St. Paul, Minnesota. Miranda.

Jo Anne Engel, Woodside, California. Zeiss Contaflex.

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Tracy M. Kramer, Jr., Mount Dora, Florida. Beseler Topcon.

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Carl Lipin, Brooklyn, New York. Pentax.

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William H. Nickerson, Greenwich, Connecticut. Pentax.

Elmer E. Nielson, Burbank. California. Pentax.

Susan H. Nolan. Newfoundland. New Jersey. Minolta.

Kenneth C. Parkes, Pittsburgh. Pennsylvania. Pentax.

Alan Pugh. Cambria, California. Nikon.

Eleanor Earle Rolf. Minneapolis, Minnesota. Miranda.

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Walter Schwartz, Bronx, New York. Zeiss-Ikon

Frank Stevens, II, New York, New York. Nikon.

Edwin C. Symmes, Jr., Atlanta, Georgia. Mamiya/Sekor.

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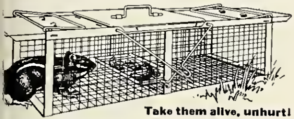

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THE ECONOMICS OF WILDERNESS

The Population Bomb. P. R. Ehrlich. Sierra Club-Ballantine, New York, 1968.

A Different Kind of Country. R. F. Dasmann. The Macmillan Co., New York, 1968.

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(GULP!)

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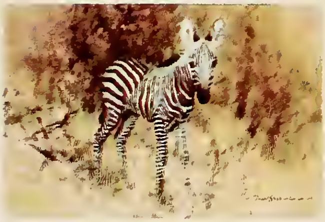
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Dec. 15, 1969 to Jan. 5, 1970 and Feb. 2nd to 23rd, 1970.

Leader of December departure: Prof. M. W. Mount, Finch College, New York. Specialist on African Art and Ethnology.

BAMAKO, Mali's capital, on the river Niger, a great ertisanate, African Museum, Sudanese architecture, rock paintings of the Grotte du Point etc.

MOPTI, an ethnic crossroad with many tribes in the picturesque Komoguel quarter: Bozo, Somono, Peul, Bambara, Dogon, Toucouleur, Marca and Amra.

SANGHA AND THE DOGON VILLAGES on the Plateau and in the cliff-area (falaise) of Bandiagara. The Dogon and their country are one of Africa's most fascinating experiences. The cosmology, totemism and ancestor cult of the Dogon, their masks, masked dances, funeral rites, ceremonies, sacrifices and art have been the subject of much ethnological research. See our tour booklet for an extensive description. Literature is mostly in French.

ABIDJAN with its great Museum of African Art and the Banco National Forest.

DAHOMEY: Capitals of the old kingdoms of Abomey, Allada and Porto Novo. The Adja Fon, their royal palaces, their art and nature religion. The spirit enclosures and secret societies of Ouidah. The world's last lacustrine city of the Aizo fishing tribe.

A day in **DOUALA** with a great museum. Then by air to *Garoua* for a *safari in the savanna of North Cameroun.* Here, some of Africa's most primitive tribes will be seen: the Kapsiki, Mofou and Matakam. Meeting with the chief of the Oudijila, his court and his wives. Dances in Rhumsiki and Meri. The 'kirdi' tribes of North Cameroun are another great African ethnological attraction.

WAZA ANIMAL RESERVE with elephants, lions, giraffes and antelopes.

MAROUA, the capital of the Diamaré, an immense city of straw covered round huts. The Museum of the Diamaré Fantasia at Meskine, a spectacle of medieval Islamic knighthood, by the cavalry of the Sultan. Independence Day in Maroua on January 1st and 2nd.

CHAD. Flight from Maroua to *Fort Lamy* in Chad. Excursions on the Chari River and to the borders of Lake Chad. Return via Paris. *All inclusive from New York: U.S. $1895.00.* Ask for booklet.

THREE KINGDOMS OF THE HIMALAYAS

BHUTAN — SIKKIM — NEPAL

November 4th to December 2nd, 1969

April 16th to May 14th, 1970

Led by Mr. M. A. Badshah, an Indian friend of ours, who has led several of our tours on the Indian sub-continent. Mr. Badshah is a high Indian government official, an internationally known conservationist with a broad range of cultural interests and a charming personality.

BHUTAN, or Druk Yul, the land of the dragon, is a Tibetan country. Culturally it is like Tibet before the Chinese invasion. The Drukpas or Buthias are of Tibetan stock, their language is closely related to Tibetan. The state religion, Mahayana Buddhism, came from Tibet, and the spectacular castle monasteries, Buthan's most remarkable architecture, are built in the style of Lhasa. The monasteries are cultural centres of religious theater and dances and of arts and handicraft, in particular wood-carvings and metal work. The capital, Thimbu, is in the Paro Valley of the Inner Himalayas. It is reached from Silinguri in Bengal, a day's travel by car. Before the road was built, in 1962, the journey took 6 days, on mule tracks. There will be excursions from Thimbu, visits to monasteries, ceremonies, dances, perhaps an archery contest and an audience with the royal family. In due course we will mail our own travel report to the participants. In the meantime, the easiest accessible literature would be an article in National Geographic, Sept. 1961, by Desmond Doig, with beautiful photographs. Entry Permit guaranteed for group.

SIKKIM is a small country of high mountains and deep valleys. It has more than a dozen peaks of over 20,000 feet. Most people are Tsongs of Nepalese descent but there are also Lepchas and Buthias. Sikkim's capital, Gangtok, is reached from Darjeeling. Entry Permit guaranteed for group.

NEPAL, often visited on our tours, is reached by air from Benares. The greatest attraction in all three kingdoms are, of course, the Himalayas, but the towns of Katmandu Valley are rich in great art and architecture. An air excursion will lead to Pokhara.

A number of places will be seen in **INDIA,** on the way to and from the Himalayas: Delhi, Khajuraho, Agra, Benares, Darjeeling, Kalimpong and Calcutta.

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FADA, centre of the Ennedi, on the southern border of the Sahara. 500 sites of prehistoric paintings, discovered in 1957 by the Musée de l'Homme. Most sites accessible by car. The people of the Ennedi: the nomadic Tibbu and the farming Bideyat. Interesting fauna and flora: mini-crocodiles, masses of land turtles, berber lions, giraffes, birds.

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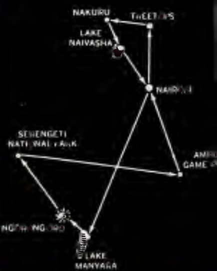

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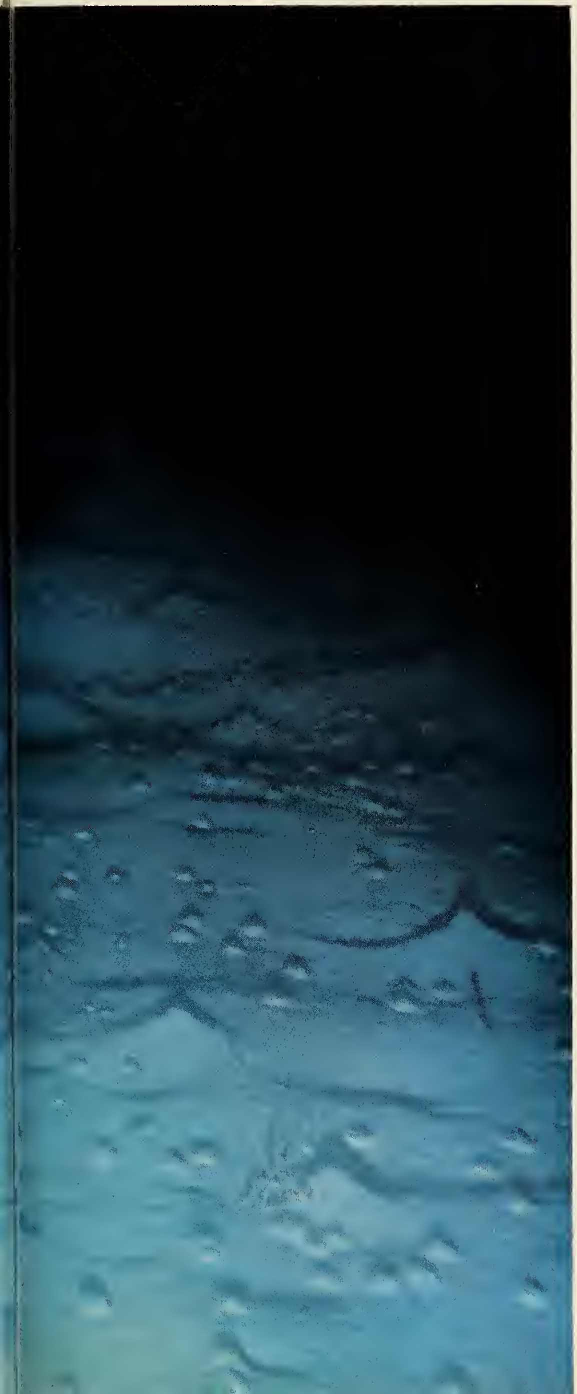

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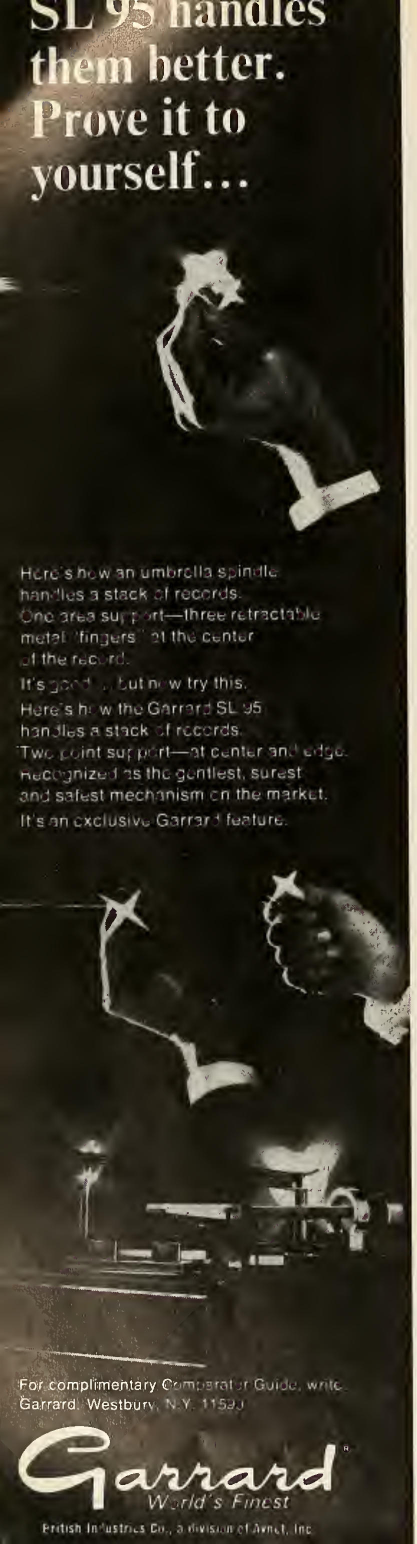
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Natural History

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COVER: *The best waves in Hawaii "rise steeply, but break with a regı curl and leave an open shoulder in front of the moving break. . . .*

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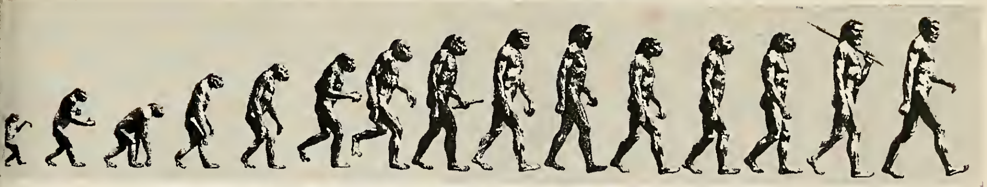
THE MOST ASTONISHING DETECTIVE STORY IN HISTORY—



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THE AUTHORS

When **Belva Jensen** was studying biological aspects of the Lewis and Clark expedition for her master's degree, her family became so engrossed in the subject that in 1967 they set out on the journey described in her article. Their expedition combined a great adventure with work on pollution abatement that Mrs. Jensen was doing at the time at Charles County Community College in Maryland, where she is chairman of the biology department. Since 1946, when Mrs. Jensen worked at the Patuxent Wildlife Refuge, she has been involved in plant and tundra ecological field work.

A three-year study of citizen conservation groups led to **Richard L. Means**'s sociological analysis of the "new conservation," This month's "Naturalist at Large." Dr. Means is a professor of sociology and anthropology at Kalamazoo College. A visiting lecturer at the Yale School of Forestry this past year, Dr. Means continued to study community attitudes toward the environment—the theme of much of his writing, including *The Ethical Imperative,* to be published by Doubleday this summer.

Belva Jensen

Since he learned to surf along the California coast in the 1940's, **Ben R. Finney** has been interested in the origin of this sport. In 1958, while a graduate student at the University of Hawaii, Dr. Finney left his seminars and archeological excavations in order to study explorers' journals, Hawaiian manuscripts, and museum collections—research that led to his master's thesis on ancient Hawaiian surfing. Now a Senior Research Fellow at The Australian National University, Dr. Finney has concentrated on studies of economic change among Pacific peoples, including a current study on the emergence of entrepreneurs in the New Guinea highlands.

James D. Houston was able to combine his interests in writing, surfing, anthropology, and Hawaiian culture when he collaborated with Dr. Finney to publish *Surfing: The Sport of Hawaiian Kings,* the book on which their article is based. A visiting lecturer in creative writin the University of California, Houston is currently writing a n in which surfing and Califo beach life figure. He is the autho *Between Battles* and *Gig,* both no published by Dial Press.

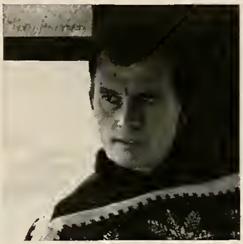
"Rarest Booby," the first lished account of this species' br ing behavior, is one of many pop and technical articles written **Bryan Nelson**. Currently dire of the Jordan International logical Station in Azraq, Dr. Ne received his doctorate from Ox University. English-born, he studied avian life from Scotla where he was Honorary Rese Fellow at Aberdeen University the Galápagos, Peru, the Jorda desert, and Christmas Island, nesting ground of Abbott's Boo Dr. Nelson is the author of two p ous articles for Natural Hist "The Man-O'-War Bird" (1966) and "Bass Rock Gann (April. 1964).

The research that led to Jos **F. Gennaro, Jr.**'s article on use of electron microscopy to s the lizard foot was done with th sistance of Franco Rossi, of the E Instrument Company, and Eu Ginzberg and Richard Meszler, students at the University of L ville when this project was ceived. Dr. Gennaro, who has m the gecko to his laboratory at York University, plans to conti using electron microscopy to st the venom gland of the snake, membrane, and cells that trans sodium and other ions.

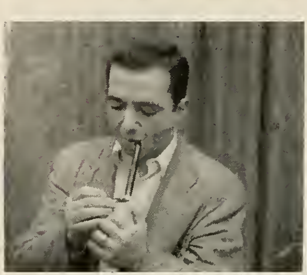
In "The Florence Floods" R **ard M. Klein** gives a plant bi gist's analysis of that recent Ita disaster. Professor of Botany at University of Vermont and an a conservationist, Dr. Klein is ently editing a volume on the im of man on the ecosystem, base a symposium held at the univer With his wife—also a plant b gist—Dr. Klein has written *Disc ing Plants,* published by the Nat History Press. A second book, *search Methods in Plant Scienc* scheduled for publication by same company early in 1970.

Richard L. Means

Ben R. Finney


James D. Houston

Bryan Nelson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In and Out of the Field

Alfred Meyer

On September 18 at 8:00 P.M., Eastern Daylight Time, many of this museum's stellar personalities will participate in a one-hour color special over the CBS Television Network. The program, "The Natural History of Our World: The Time of Man," will feature, among others, Harry Shapiro, Margaret Mead, Colin Turnbull, Ethel Tobach, and D. M. Vincent Manson. Beginning at the beginning, with the evolution of life, the program will, according to its producer, attempt to place man's position on earth in dynamic perspective and to examine his increasingly worrisome role in nature. That perspective and that role are, to my mind, admirably expressed in the Museum's Centennial Exhibit, "Can Man Survive?" which evidently inspired the television production. The exhibit opened last May in the Roosevelt Hall and is scheduled to run for two years. It is, by design, a jangling, oppressive, unsettling microcosm of our world, and to such subthemes as agriculture, technology, and population, it piles on a stream of words, sounds, images, devices, lights, and textures so cunningly effective that midway through it a lady I had taken to see it asked how in the devil could she get out of there. The television program will, most assuredly, produce no such claustrophobia, if only because of its geographic and intellectual diversity. Dr. Shapiro, for example, will discuss the problems of human population and survival. Dr. Mead will show aspects of her work with the Manus in New Guinea, while Dr. Turnbull will probe the interaction between the Ik, a tribe living on the Kenya-Uganda border in Africa, and their harsh and somewhat desolate environment. Dr. Tobach will provide a glimpse of animal behavior studies, both in the laboratory and in nature, and Dr. Manson will outline the geologic evolution of the earth with the help of the world's largest teaching aid, the Grand Canyon. All in all, it sounds like first-rate television.

A delightful mixture of scatology and scientific serendipity came to light last May at the annual meeting of the American Society of Archaeology in Milwaukee. More than a year before, in the February, 1968, issue of NATURAL HISTORY, Richard Gould of this museum observed that the Australian aborigines use their teeth in trimming the edges of their stone-cutting tools. This oral technique had been referred to before, with respect to the aborigines, by Donald Thomson, but the only other previous mention that Dr. Gould knew about came from Coronado's chronicler, Casteñada, who saw such stone flaking in the Great Plains of North America in 1541. At a symposium on the human ecology of Hog
Cave (an archeological site in Utah), held at the M
waukee meetings, Gary Fry presented a prelimin
analysis of Hogup Cave coprolites. Coprolites are fo
excrement and their analysis provides dietary and
tritional data. For example, in the time from prio
4000 B.C. to the present, Fry noted a decline in the us
pickleweed seed and an increase in fibrous foods. N
whereas soft foods, such as meat, tend to be comple
digested and leave little or no record in coproli
harder items like hair or coarse vegetal matter bec
a residuum in coprolites, providing a basis for iden
cation. This is where Dr. Gould's observation on
aborigines becomes relevant, for Fry disclosed that
specimen dated before 4000 B.C. contained tiny cl
of obsidian, and several specimens dated after 2600
contained chips of chalcedony. Fry raised the possibi
that these chips represent debris from tool sharpen
with teeth. He calls the chips debris; I call them crun

NATURAL HISTORY, for all the atavism some reac
say they detect in our pages, is inescapably part of
twentieth century. As much as we may, from time
time, evoke a simplistic and romantic world, wherei
principles, ecologic and ethical, are equilibrating i
way that makes life handsome and shining, we do so
times run smack up against reality. One such insta
occurred late this spring. Happily enough, our circ
tion has grown to well over 200,000. But, as any po
lation ecologist knows, a substantive change in quan
results in a change in properties. We found, for exam
that we simply could not address, mail, bill, renew,
otherwise keep track of that many subscribers with
same hand-operated, comfortable, more or less intin
methods we have used for the past thirty years. Co
quently, we decided to computerize that part of the m
azine, beginning with this very issue. Needless to
we have less than total faith in our technological
which explains why several of us are walking aro
these days invoking that primitive deity who suppos
responds to a crossing of fingers. We have, it see
every reason to believe that a random few of you
there will fall victim to the vagaries of permissible
chine error. This will mean, at best, that these unfo
nates will receive, not one, but two or possibly
three copies of the August-September issue. And
worst, they will receive no copies of NATURAL HIST
but, instead, a combined bill for seven years of
Ladies Home Journal, *The Wormrunners Digest*,
The East Indian Journal of Philately. The permutati
you see, are alarmingly infinite. We therefore
beg your indulgence and ask you to please compla
bitterly, if necessary. For, in negotiating with
computer, we were given to understand by a some
lengthy print-out that the "bugs" (a quaintly ento
logical expression) would not be ironed out of the
tem until several months had passed. We could
however, pin the machine down to an exact date. Fin
may I ease the disquietude of those who fear that, ha
gotten a toe hold, the machine will impinge on
editorial content of the magazine. NATURAL HIST
will continue to have editors who are imperfect, en
siastic, rigorous, petulant, honorable, and human.

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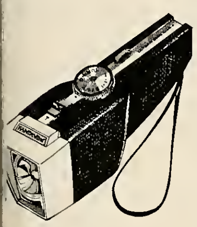

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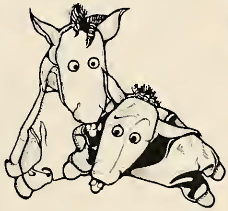

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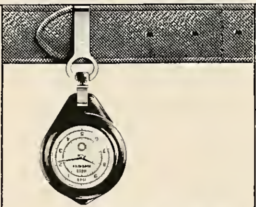

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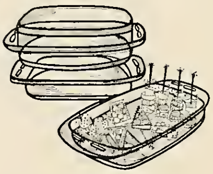

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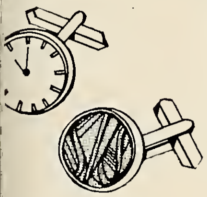

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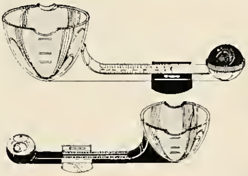

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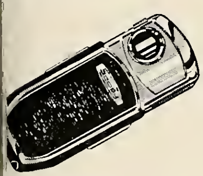

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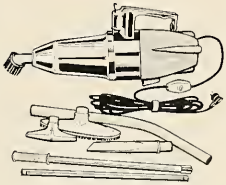

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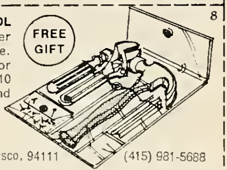

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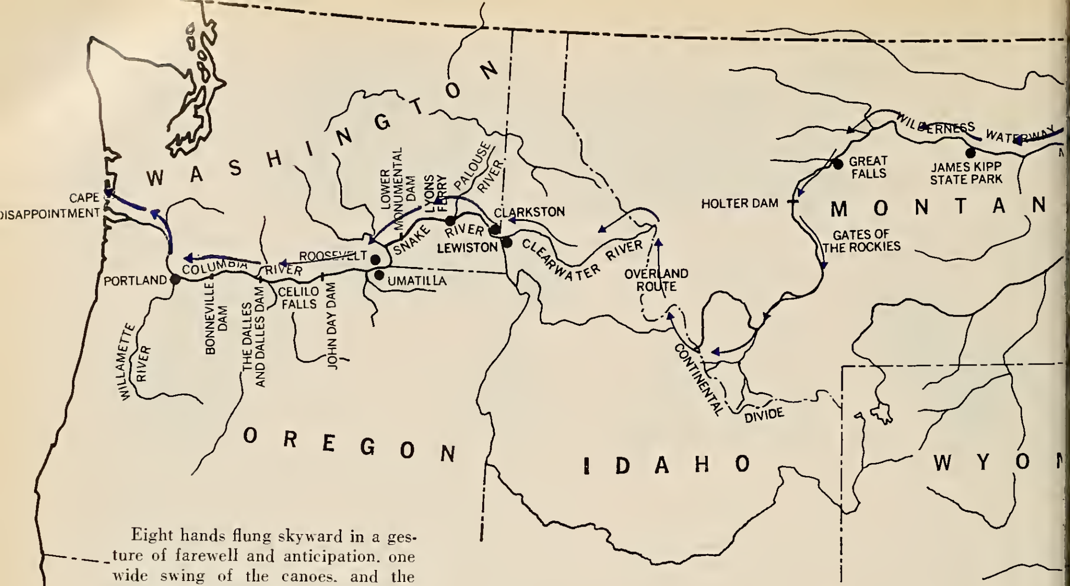


Eight hands flung skyward in a gesture of farewell and anticipation. one wide swing of the canoes. and the motors were opened up to propel craft and crew straight as a die across the Mississippi and into the mouth of the Missouri for the first retracing of the Lewis and Clark water route from the Mississippi to the Pacific Ocean. It took Meriwether Lewis and William Clark over two years—from 1804 to 1806—to complete the expedition that ranks. according to historian Bernard De Voto. second only to Columbus's voyage in its impact on history. With modern equipment and up-to-date maps. our group of eight. biologists and students. would attempt to cover the same route in two months.

Our expedition consisted of three college professors and five students. Tom Mayer. Mike McNerney. and Cliff Startup were all college students; Karen and Nancy Jensen, high school students. We also had a youngster, Erica Jensen. 6. with us on the first half of the trip. Ecologist Dwayne Maxwell. biologist Roy Jensen, and I had a course to develop in stream ecology and needed to test water-sampling techniques for our college's curriculum in pollution abatement technology. I had done a great deal of my master's work on the biological aspects of the Lewis and Clark expedition. and knew that their journals held a wealth of information with which we could compare our findings. We were anxious to experience the adventure of the Lewis and Clark route. and to observe the ecological changes that had occurred along this route since the days of early exploration.

Lewis and Clark started their journey from Wood River. Illinois, on May 14, 1804. They had spent the previous winter in nearby St. Louis. devoting their time to training and instilling military discipline into their small band. as well as gathering supplies and equipment. According to the journal. they "set out at 4 o'clock p.m., in the presence of many of the neighbouring inhabitants. and proceeded on under a jentle brease up the Missouri." They traveled in three boats—two pirogues, or open row boats. and a 55-foot keelboat. Two horses. led along the banks, were used for securing game and making observations. We started with a travel van, to pull a trailer and to portage canoes: a small car for reconnoitering; and two square-stern aluminum canoes propelled by 6 h.p. engines. Our costs eventually hit $25.000—a far cry from the $2.500 Congress appropriated to send Lewis and Clark. and their 40 men, on a two and a half year journey.

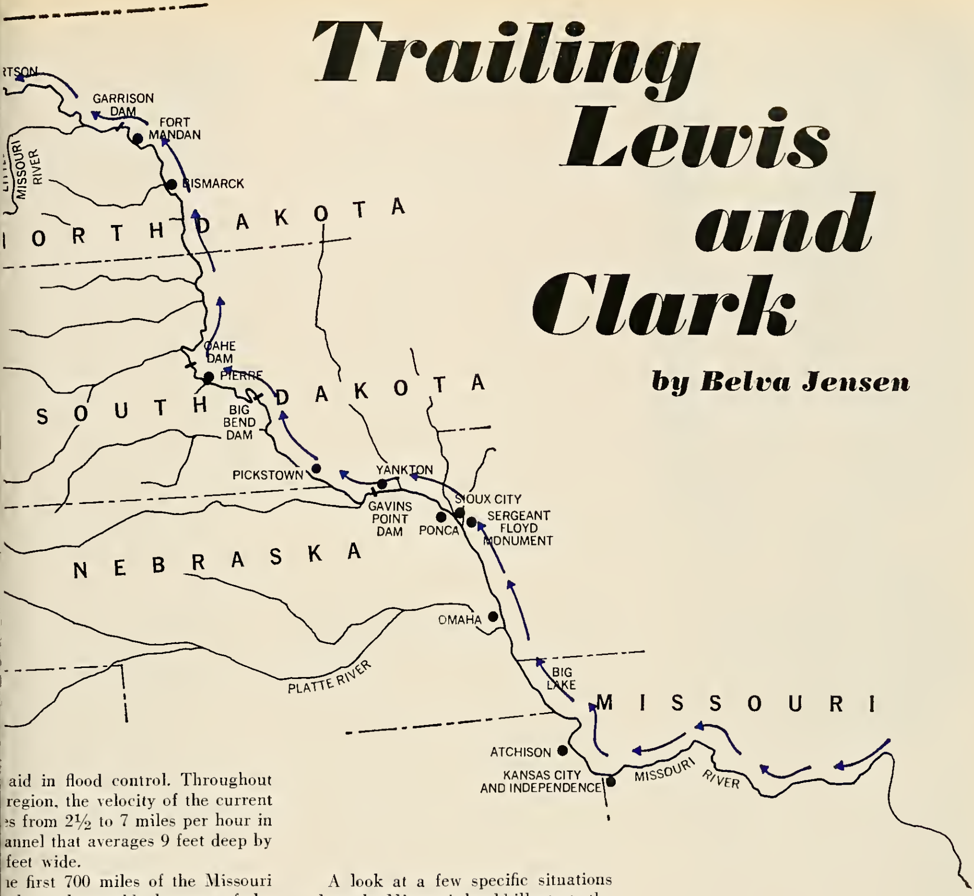
Our trip proved to be not only a great adventure. but it also provided us with an ecological picture of the great rivers traveled by Lewis and Clark—the Missouri. Clearwater. Snake. and Columbia. It is not—overall—a pleasant picture. Time and again we saw raw sewage being dumped into the waters. Cattle and sheep by the thousands erode the banks of the rivers and pollute the waters. A multitude of dams. while they prevent some of the floods that once plagued the area. have created large stillwater lakes. These contribute to water pollution and destruction of aquatic life (including migrating salmon) and have, in some cases. inundated regions of great sc
beauty. And more dams are pla
that will destroy much of the unsp
parts of the Missouri, Snake, and
lumbia rivers. On the lower Miss
between Independence, Missouri,
Big Lake. we found some county
state recreational facilities along
Lewis and Clark route. but they
overcrowded and poorly mainta
On the still sparsely populated u
Missouri. we found the people dist
ingly unaware of the need to kee
river clean. still clinging to the
that when you dump something
river—be it cars. lumber. or sew
the river will make it disappear.

As a formal scientific treatise
diaries are not of great value. D
our limited time. we could not c
or spend the time in observation
Lewis and Clark did. even thoug
had professional biological
grounds. Scientifically. both diarie
somewhat superficial. Even so,
over-all observations and the info
tion gained by personal contacts
ing each of these trips are of v
theirs in regard to the opening o
West; ours. to understanding th
vironmental problems that pres
exist along the route.

The first leg of our journey exte
from the mouth of the Missouri,
Wood River. Illinois. to Ponca.
braska—a distance of 752 miles. T
this stretch of river is largely
trolled by the U. S. Army Cor
Engineers, whose dams and imp
ments facilitate commercial navig

Trailing Lewis and Clark

by Belva Jensen



aid in flood control. Throughout region, the velocity of the current ›s from 2½ to 7 miles per hour in annel that averages 9 feet deep by feet wide.

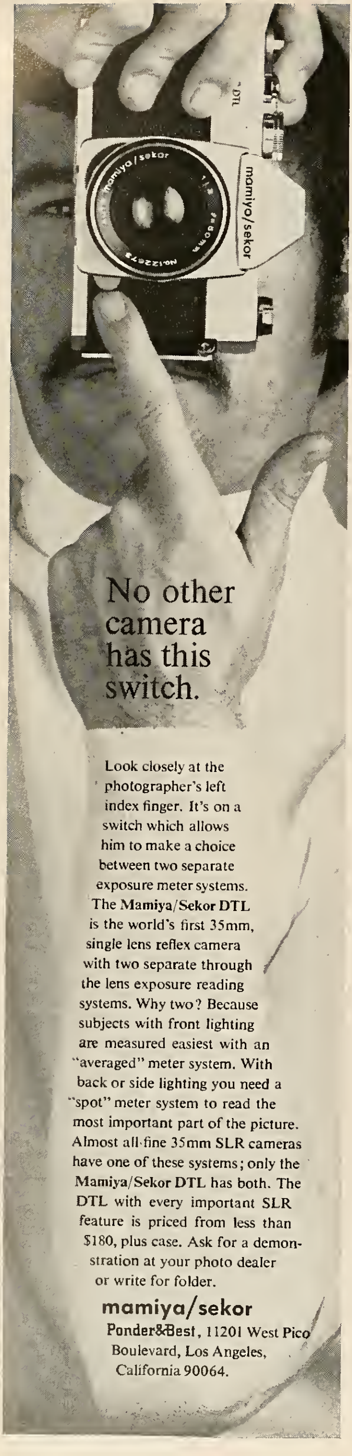
ıe first 700 miles of the Missouri always be muddy because of the sandy silt through which the river its channel. However, an even finer ·omes in from surface wash-off and cts in the gills of the fish, causing :ness and death by blocking the ange of oxygen and carbon di-ɜ. Another characteristic of the ouri is that the amount of dis-d oxygen in its waters is always This is a favorable situation, for ·iver does not contain enough dis-d oxygen to chemically break ı the wastes placed in it and still n the amount required for the nor-life needs of water animals, it be-s "degraded" or "dead."

spite the high oxygen content, not ·astes dumped into the Missouri successfully oxidized. Wherever rials are dumped that change the ty or alkalinity of the water to a where bacteria will not live and duce, no biological oxidations ·ake place regardless of the oxy- supply. This is the case along of the river.

A look at a few specific situations along the Missouri should illustrate the changes that have occurred in the river since the time of Lewis and Clark. During our first day of travel, for example, we made an unexpected stop in New Haven, Missouri, at the request of a local newspaperman. He had heard of our coming and wanted to talk to us about his concern for the river. Four years ago, the town dug a lagoon in preparation for building sewage treatment facilities. Since that time, however, the town has continued to dump raw sewage into the river because it hasn't been able to get the federal assistance it needs for completion of the facilities. We were to encounter this problem again and again, indicating to us the need for such towns to become familiar with the technique of "grantsmanship."

Today the barge lines moving up and down the river cause great problems for small craft, owing to the tremendous displacement of water and the surge that may suck them under or flip them over if they catch the wake broadside. In 1805, there was little worry over barges, and Lewis and Clark spoke frequently of their sense of isolation on this leg of the journey. We were to experience this feeling only rarely, for today towns are spaced along the river every 25 miles or so. Lewis and Clark's isolation meant they could bathe (in clean water) when they wanted to—and we envied them.

The riverside campgrounds maintained by the individual states somehow failed to complement the potential majesty of the waterway. They appeared to be designed largely for convenience with little thought given to esthetics. While most sites, like so many products of our society, were mass produced and seemed to attract careless hordes of people, those that were more carefully tucked away with attention to protection of the surroundings and creation of privacy were apparently treated with more respect by visitors.



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In areas close to the cities the demand for camping and recreational facilities has increased so much faster than any land purchases for recreation that campground crowding is inevitable. We were scheduled to spend the night of June 24 at Lewis and Clark Park at Atchison, Kansas, but had to change our plans and proceed upstream 20 miles because there was no camping space left in the park.

The bend and oxbow riverbed formation is typical of the Missouri in the Omaha region, a result of the river's lazy meanderings through the flat country. The story is told that on a scouting party, Captain Clark found himself only 375 yards from the previous nights' camp while the river distance between the two points was 12 miles. While camping along one of these oxbows, we had our first encounter with Indians. Finding we were not far from the tribal headquarters of the Winnebagos, we went to visit. The Winnebagos remain in control of their lands and are now developing a large reception area with docking, picnicking, and camping facilities. The income from these will revert to the council for further expansion of tourist facilities. The women do beadwork, mostly decorating combs and earrings. But despite their seemingly successful beginning at entrepreneurial endeavor, one can't help but speculate on the sometimes negative effects on the young Indians of attempting to assimilate into the mainstream of American society. With more training and job opportunities, it may be possible to provide employment for the Indian and still retain the customs and traditions of each tribe, as well as collective and individual self-respect. This is probably an oversimplification, however. The real danger involves the degree to which the young Indian is seduced by our culture, with the consequent neglect of his own.

Throughout the first leg of the trip, I kept trying to compare the flora and fauna of the present to that seen by Lewis and Clark. We could find no wild turkeys, wolves, bear, or deer. Buffalo were conspicuous by their absence—replaced long since by herds of Angus and Hereford cattle. The coon and muskrat, and all of the small mammals are still plentiful, and most of the plant life remains the same along the river. It is only when you are in an automobile or on foot a few hundred yards away from the water, that you are aware of a totally changed biotic community—altered according to the tastes of man.

We continued our journey upriver past the mouth of the Big Sioux River and stopped to visit the monument to Sergeant Floyd—the only fatality of the first expedition. The heat and the l
cobalt content of the water (wa
down from the bluffs to the so
gave Lewis's men severe stomach
orders. By agitating the water to
perse the scum, they could drink f
a depth and the disorders ceased.
crew was also beset by "biles
tumors" and other sores that would
heal. These too, Lewis attributed to
minerals washed into the river from
mineral-rich countryside. Our c
members, too, had sunburned lips
became infected and took over a m
to heal even when treated with an
otic creams. We feel that there was
stant reinfection from the spray of
luted waters, rather than from the m
erals in the water. The pollutants
being dumped into the lower Miss
bear some resemblance to those L
and Clark encountered, but are
more toxic and are present in gre
concentrations. The early explo
found vast areas of the river filled
rotting carcasses of buffalo, which
drowned when they were forced
the water by the hunting parties
Plains Indians. However, the addi
of industrial wastes and insecticide
the hides, grease, entrails, feet
paunch manure from today's slaugh
houses along the Missouri, has cre
a chemical oxygen demand that ca
be overcome. The wastes from feed
along the Missouri are dumped dire
into the river, and 10,000 cattle
duce as much waste as a city of 100,
people. Even chlorination of all
domestic wastes would not destroy
viruses now transmitted by the rive

On the evening of June 29, we loo
out from a promontory at a site be
Gavins Point Dam, Nebraska, ere
to control the meanders and occasio
flooding of the river and to gene
hydroelectric power. During the
ning, the water level behind the da
raised by restricting the flow of
river. This creates lowered river le
and higher water temperatures be
the dam. Then, as the backed-up w
is released from the dam during
daylight hours, generating electric
the river is raised and chilled. T
daily alternation in temperatures
water levels has a lethal effect u
aquatic organisms. The food chain
the river is altered and the number
size of game fish are cut down.
creation of dams is certainly a mi
blessing, and once they are in pl
they completely alter river ecol
both above and below the dam site
addition, the extensive damming
destroyed much of the river's vari
creating a certain monotony in
landscape.

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Lake into a beautiful, natural river

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and others
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Cape Horn
Port Williams
PATAGONIA:
Punta Arenas
BUENOS AIRES

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BUENOS AIRES
PATAGONIA:
Punta Arenas
FALKLAND ISLANDS
Fox Bay
Carcass Island
West Point Island
Port Stanley
ANTARCTICA:
South Shetlands
Deception Island
Antarctic Peninsula
Anvers Island
Argentine Islands
Lemaire Straits
and others
TIERRA DEL FUEGO:
Cape Horn
Port Williams
PATAGONIA:
Punta Arenas
BUENOS AIRES

THIRD EXPEDITION

BUENOS AIRES
PATAGONIA:
Punta Arenas
ANTARCTICA:
South Shetlands
Deception Island
Antarctica Peninsula
Anvers Island
Argentine Islands
Lemaire Straits
and others
TIERRA DEL FUEGO:
Cape Horn
Port Williams
PATAGONIA:
Punta Arenas
BUENOS AIRES

FOURTH EXPEDITION

BUENOS AIRES
PATAGONIA:
Punta Arenas
TIERRA DEL FUEGO:
Magellan Straits
Magdalena Island
FALKLAND ISLANDS:
Fox Bay
Carcass Island
West Point Island
Port Stanley
SOUTH GEORGIA:
(FIRST TOURIST VISIT
IN HISTORY)
Grytviken
King Edward Cove
East Cumberland Bay
Doris and Kelp Bays
Moltke Harbor
Stromnes Bay
Bay of Islands
GOUGH ISLAND
TRISTAN da
CUNHA ISLAND
CAPE TOWN

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Jeffery Boswall
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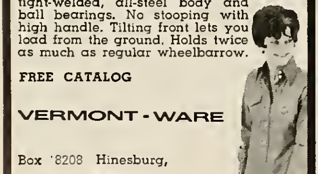

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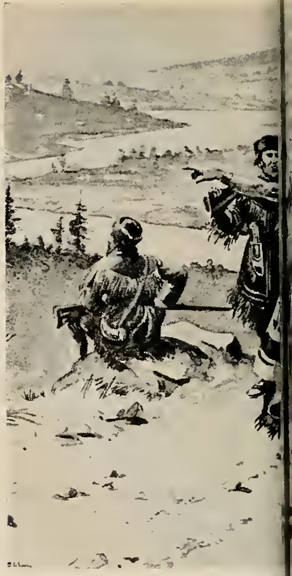


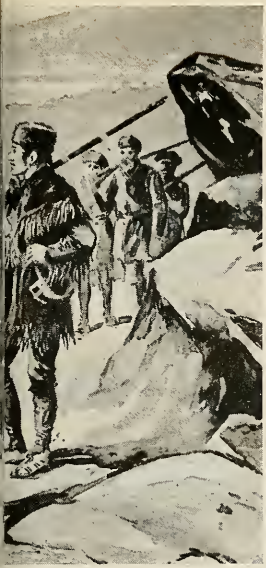
Lewis and Clark prepare for the c
passage through the Rockies.

gion where you can still see the M
souri as it once existed in its erratic
meandering state—its banks still li
with willows and dotted with swallo
nests. Muskrats tunnel into the ba
and blue herons fly above them. Un
tunately, the beavers have not been a
to stage a comeback from the trapp
that has decimated their numbers.

The second part of our journ
which took from July 7 to July 17,
a study in contrasts, for the river fi
Pickstown, South Dakota, to the ot
side of Fort Peck, Montana, is
most completely controlled by da
There is little resemblance to
original Missouri or to any other ri
for that matter; the huge reservoirs
more like bays than anything else.
had been warned of the speed w
which squalls whip up on these la
man-made impoundments. and as
entered the reservoir behind the O
Dam, we decided to stay fairly close
shore. A small craft can be more ea
overturned by wind-driven waves in
reservoirs than in the protected ri
channels.

The coves along the shore of O
reservoir were lined with the gı
white trunks of trees that had b
growing in the area before the d
backed up the river and killed th
Now, ten years later, they presen
stark contrast to the deep blue sky
blue green water.

In North Dakota the country al
the Missouri remains sparsely po
lated, with only a couple of towns al



iver between Bismarck and Gar- Dam to the north—a distance of iles. The country is beautiful here he river even more so. When we ɔ camp on the riverbank at 10:00 the moon was clearly visible, al- h it was still daylight. This cast hereal glow over the riverscape left us with a peaceful feeling. outward appearances, the region le changed from its original state ing grassland. Yet there were ions that created some uneasiness r group that night and prompted a speculation into the region's fu- Why had the two fish we caught day been covered with a water (fungus)? How will the dams and below this area alter river What will happen in the future the reservoirs silt in and form t mud lake and finally a high flat ? What life will be there then? ondered if in the future, due to an iative power source, there were no for dams would we have the social ility to abandon their use and re- the river to its natural condition? d the dams be removed?

e Lewis and Clark expedition ar- near the present site of Bismarck, ı Dakota, on November 2, 1804. ng for six months, they built Fort lan and attempted to collect as information as possible on the aphy and topography ahead of From here on they entered land before traversed by white men. ouldn't help wishing that our own carried as many unknowns. We

Continued on page 64

The Romance...
The Beauty...
The Adventure...

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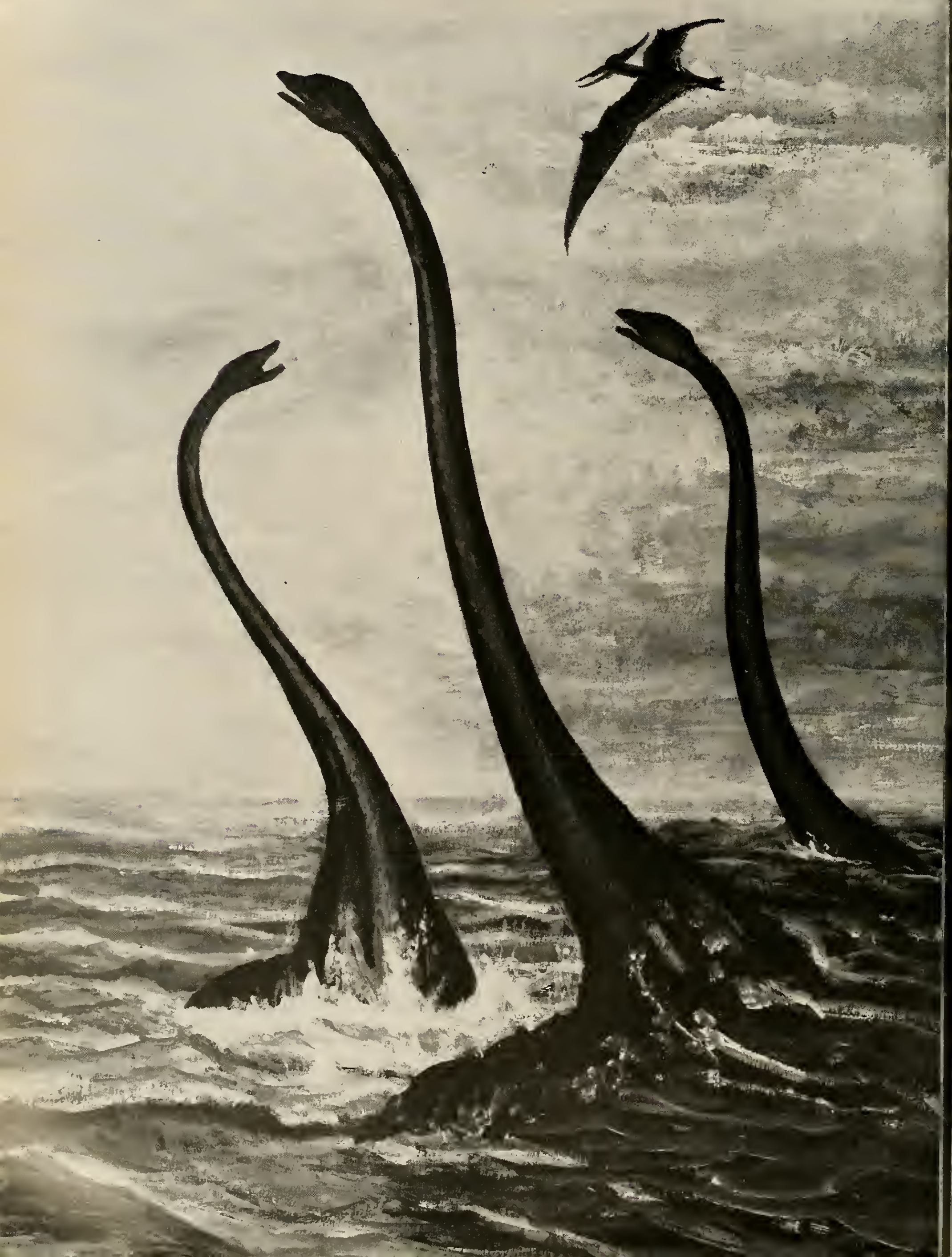
H-2

"In nature's infinite book of secrecy, a little I can read."

—*William Shakespeare*



y, nature's "book of secrecy" is wide open,
ing to be explored. And what a glorious
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rowded jungles and the quiet woods, the
ral worlds of beast, bird and insect, the
erious worlds of man's first beginnings. You'll
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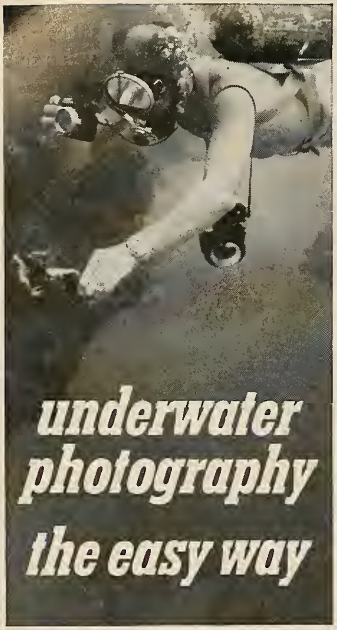

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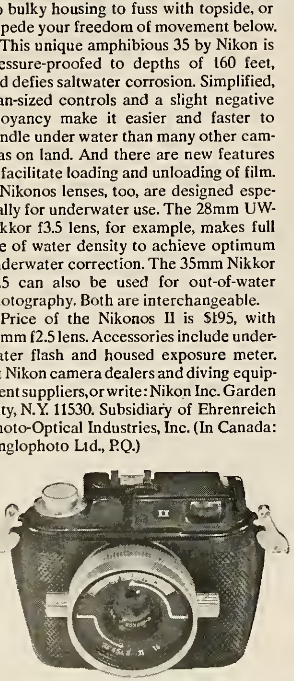

NIKONOS II
by Nikon

A Naturalist at Large

The New Conservation

by Richard L. Means

The magic word for this decade is "relevance." Everybody seems to be caught up in the search for relevance. Ministers, students, psychiatrists, and even politicians eagerly respond to the endless incantation of this magic word. Fortunately, the question of "relevance to what?" has a way of intruding itself on the more somnolent forms of contemporary escapism. One cannot completely escape—unless in lunacy—the realities of one's own society and history. Thus there are objective realities, outside the framework of egotistical whimsy, to which man has to relate to find relevance and to test his own experience. The world of nature, the environment of man, may be such an anchor point where man can discover a partial sense of permanence in a world of shifting relativities.

There is evidence that many people are attempting, consciously or unconsciously, to speak to this issue—the problems of order and chaos. It seems that some of the best answers are coming from a group I call "the new conservationists."

It is true that different groups seem to march to different drums. Each one—black or white, Catholic or Protestant, rich or poor—puts forward a special interpretation of the world. Ideology, the preaching of group-interest, seems to be the ruling passion of the day. However, the question is seldom asked of how men and institutions may be related to the general welfare. Undoubtedly many people in our society have special social needs: the black ghetto mother, the chronically ill retiree, the psychotic, the drug addict, etc. But how may we transcend individual and private interests and speak intelligently and objectively about the general public good? Is there
any place today—other than in t
world of abstraction—where we c
find hope, at least in part, that t
public good will be represente
Again I believe there is an answ
and that answer lies in a growi
social movement, "the new cons
vation."

What is this social movemen
First, and paradoxically, there is
sense in which it is not new. Li
every valid social movement in
democracy, its meaning is express
in the lives of ordinary men a
women. The "movement" is an ir
housewife who tries to sue her st
government after an airplane swoo
down over her clean wash flutteri
in the afternoon breeze and spra
it with a deadly, sticky insectici
The movement is also a small gro
of men and women standing, duri
the Christmas season, beside a riv
in Connecticut. They hold th
noses because of the stench and
cay of the once clean river and pr
to God for forgiveness for what m
may do to the earth. It is, as w
scientists and citizens who meet
fore a state commission to protes
new highway threatening to destr
thousands of acres of marshland.

The truth is that the people
volved in the new conservation co
from all walks of life.

Second, most of the new cons
vationists are not sentimentalists
what are sometimes called "pu
preservationists." They are often
sons and daughters of the corpor
world who do not respond easily
romantic primitivism. They und
stand William H. Whyte's dict
about preserving land and op
space (*The Last Landscape*, 196
when he says "use it or lose it." A
they understand why, when Ste
T. Mather was made the first ch

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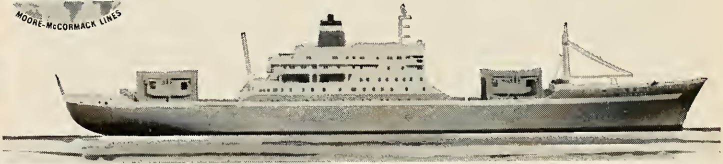

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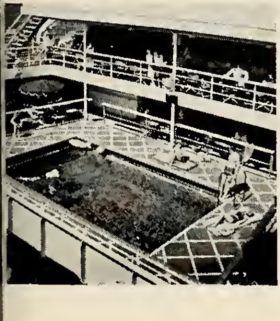

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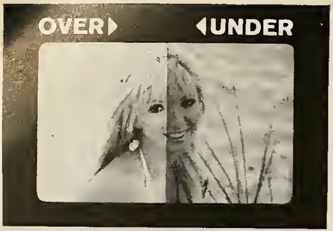

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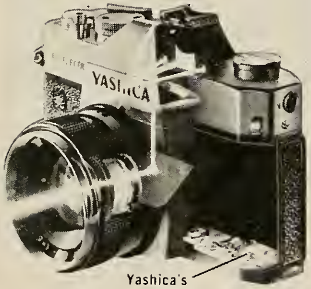

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of the National Park Service, he insisted on building roads so the public could see the national parks. Although he was immediately accused of destroying the parks—some people wished to keep nature locked up as a private preserve, to be enjoyed only by those with a great deal of money or free time—it may prove to have been one of the great statesman-like acts of American history that this pure preservationist doctrine never prevailed. By and large, the new conservationists are, whether they know it or not, supporters of Mather's idea.

The general policy of the National Park Service and the Forest Service has been—as much as their limited budgets allow—to open the public domain to camping, fishing, hiking, and other outdoor activities. As a result, millions of Americans living in cities have had the opportunity to secure at least a glimpse of the wonders of nature in America. Thus, many have been encouraged to increase their appreciation of natural beauty.

This, then, brings us to the third characteristic of the new conservation—that more and more Americans are not just limiting their perception of nature to what might be called "the great outdoors," but are applying (at an increasing rate) their moral and esthetic appreciations of nature to the total environment. It is a central characteristic of the new conservation also to be concerned with the complete environment—city and country. In the realm of nature, the old dichotomies between city and rural life no longer prevail in quite the same way. The mighty Hudson River is just as polluted miles above New York City as it is in the city itself—equally reprehensible in either instance.

A fourth aspect of the new conservation is its scientific character, especially its relationship to the relatively new science of ecology. (Ecology is the systematic study of the entire environment, or ecosystem, which includes the relations between land, plants, animals, *and* man.) The new conservationists are not simply democratic, practical, and concerned with the total environment—they are also amazingly well versed in scientific matters related to the environment. If they lack expertise, more and more citizens'
groups are co-opting environmen
scientists into political action
counselors and guides (as in the ca
of the West Michigan Environmen
Information Center). This brings
to a fifth characteristic of the mo
ment—its stress on problem solvi

Since it is the essence of the n
conservationists to search for sci
tific and rational descriptions of t
causes of environmental contami
tion, and since each environmen
problem is always part of an ec
logical system that is unique, t
movement is partially saved fro
becoming politically doctrinaire.
cannot place the blame simply
one individual or class. In sho
scapegoating is out.

Take the case of the pollution
Lake Erie. The runoff of phospha
fertilizers from hundreds of Oh
farms has had a significant role
the pollution of the lake. The pho
phates (and nitrates) became nut
ents for a fantastic growth of alg
in the lake—accelerating the natu
process called *eutrophication.* T
western basin of Lake Erie is co
ered, during the summer, with
800-square-mile mass of algae, tw
feet thick. This tremendous alg
growth, in turn, removes much
the oxygen from the water, whi
makes life impossible for the mo
desirable forms of life (game fis
etc.), and also makes swimming
messy and risky business. As
result, the value of Lake Erie as
recreational resource has declin
tragically.

But can one blame just the Oh
farmer for what has happened? N
exactly. There are many factors i
volved that mean the responsibili
(if it can be established) has to
shared. Industries and municipa
ties that dump their wastes into t
lake are also to blame. The truth
that no one could foresee the trag
consequences of the many ove
sights of the past. Also, certainly
the case of the farmer, competi
values have been involved—the c
sire for high crop yields, an imm
diate gain, versus the results of fe
tilizer runoffs perhaps hundreds
miles away. It would be foolish
expect the typical farmer to be at
conscious of the consequences of l
use of the new chemical fertilize
Furthermore, more obvious targ
responsible for the biological dea
of the lake have been readily at ha

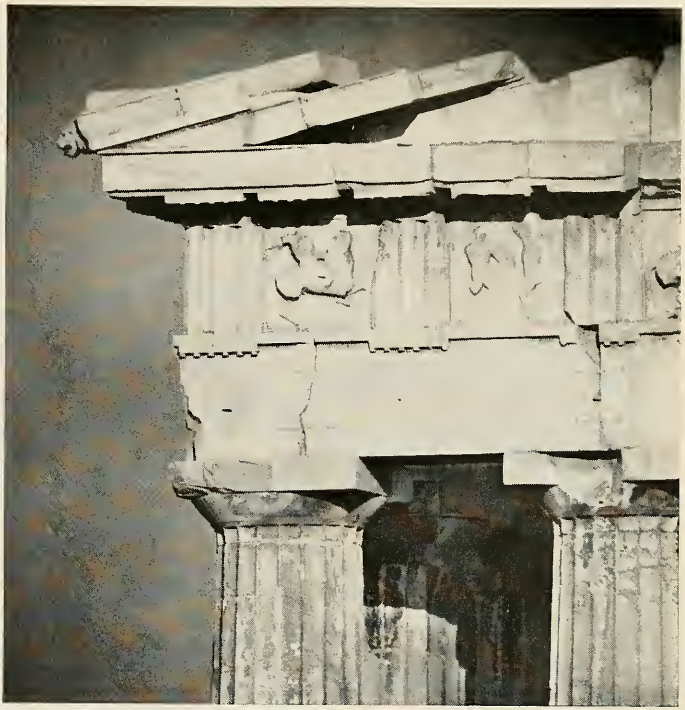
l thus are more salient targets for blic anger.

For example, the flotsam of Ohio lustrial life floating for these ny years down the Cuyahoga er at Cleveland has been apparent anyone with eyes to see. The river in open sewer, and moved George wart, the nature writer, to refer American civilization as a “nation crud.” The Cuyahoga River is haps the only river in the world t is a fire hazard; it is so full of and various products, all intering, that it continually produces thane gas. In November of 1952 aught fire and caused a million lars' worth of damage—and it is orted that it is as much a hazard ay as ever.

The new conservationists believe t those who directly pollute the ironment should be policed; ex- ng laws and penalties should be engthened and enforced. Never- less, they recognize that pointing finger of blame, in relation to t actions and in a categorical y, is not an adequate conserva- n policy. What is evident to the v conservationists is that the blem of environmental deteriora- n involves myriad factors and ses; and, in turn, it must be cked on a broad front. The prob- n is, what do we do now?

From the scientific view, ecology vides part of the answer, for it cribes the many interacting ses that have upset the traditional ance of nature, and it suggests t man must work to redress the ance or he is in trouble both m the point of view of public lth and in terms of creating a ble environment.

As a consequence, an important racteristic of new conservation hat it is more than a practical, nocratic, and scientific response various citizens to America's ding landscape. Its chief distinc- n (and in the long run its great ential contribution) is that it is ing birth to a viable doctrine of lic welfare. Although nascent at stage and just beginning to find articulate spokesmen in such men Barry Commoner (*Science and vival*, 1967) and Paul Shepard *an in the Landscape*, 1967), *there* evidently a groping for a new ial ethic capable of relating man nature—a search and desire for



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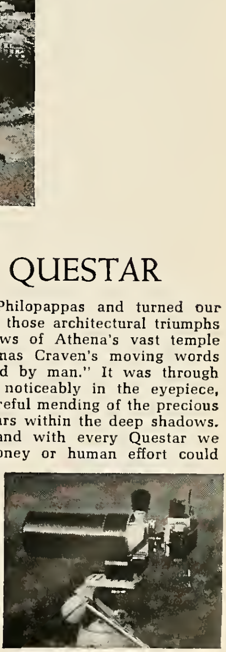

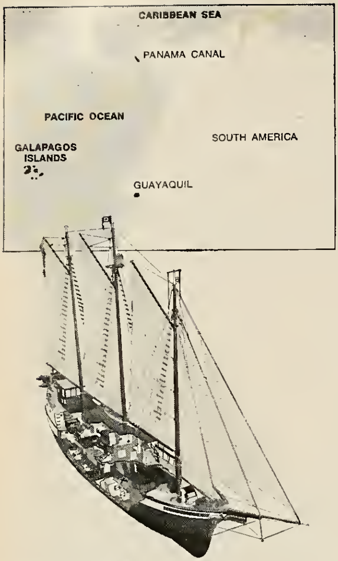

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what Aldo Leopold years ago called an "ecological conscience."

This new ethic stresses the search for an optimum use of the realities of existence—air, water, land—as the very substratum of human life itself. The mode of consideration is objective and scientific (ecological). The idea is that men's actions must test themselves against what we do to nature, because in the long run our actions are transferred through nature to future generations.

The question now arises—if there is a new conservation movement (inchoate and just beginning), why did it arise at this stage of American history?

There are many plausible reasons one might put forward in answering this question. First, and almost painfully obvious, is that the despoiling of the natural environment—the pollution, overcrowding, and misuse of our resources—is more widespread and visible to the general public today than in the past. Beaches and lakes in many areas are grossly polluted; campgrounds are overcrowded—partially a result of population pressure. Exhaust fumes in the city, coupled with thermal inversions and smog, as well as pollution accidents (such as the offshore oil slicks in California or the *Torrey Canyon* disaster in England), are likely to become more prevalent. In addition, due to our knowledge of the effects of cigarette smoking on the body, we are more conscious of the health hazards of bad, polluted air (*see* René Dubos, *Man Adapting*, 1965).

A second factor—more important because possibly it is little recognized—is the paradoxical fact that the traditional goals of the "old conservation movement" have been too narrow and are now questioned because they have been surprisingly successful. Nothing can kill a social movement more quickly than success. A successful movement easily loses its élan, its energy, and it is apt to turn to the problem of keeping the bureaucracy going, administering the plans already made. Something of this order has happened with the United States Forest Service, one of the great achievements of the old conservation, which is well described in Herbert Kaufman's book, *The Forest Ranger: A Study in Administrative Behavior*, 1960.

The organizational structure o the Forest Service, as described b Kaufman, is a kind of hybrid off spring of the Methodist Church, th Jesuits, and the U.S. Army. This ha led to a very efficient organizatior but it has also meant that creative innovative minds concerned wit conservation issues in the genera society were apt to look elsewhere outside the official bureaucracies, fo a place to express their concerns. believe that it is these people wh have become, in many instances, th leaders of the new conservation.

The old conservation movemer was dominated by two tradition: One, symbolized by Theodore Roose velt and Gifford Pinchot, was cor cerned mainly with the preservatio of America's forestland (an obviou cash crop). Pinchot introduced sc entific forestation to America, an the legacy of this effort is the U.S Forest Service (the Department c Agriculture). The second, symbo ized by John Muir, was concerne with scenic preservation and th establishment of parks. Its grea legacy to the American people the National Park Service (Depar ment of the Interior).

Both aspects of the old conserva tion movement have been highl successful and, in principle, hav won most of their major battles. Th Forest Service introduced scientif forestry across the United States. few decades ago it was fashionab to talk about the coming "timbe famine," but it is now clear that th is no longer a central issue. (The is some evidence that at one time th Forest Service published low timbe estimates in order to pressure Co gress into appropriation of mo funds for research.) Today the Fo est Service holds millions upon m lions of acres of land in public trus much of it to be developed for recr ational purposes. The same succe story is characteristic of the Nation Park Service. We have perhaps o of the best-run and most adequa national park systems in the worl There are, of course, continual pro lems such as population pressure campgrounds (Yosemite is a class case) and a few battles to be foug over specific park sites (as the r cently proposed North Casca Park). Yet the truth remains th given the traditional goals of the federal agencies—the preservation ests and the protection of scenic ıders—these two agencies have illed their mission well, and much their time, budget, and staff rgy now goes to the tasks of ninistration.

\s we have said, for a social move- at to be successful it needs ar- ulate spokesmen. Furthermore, in case of environmental contami- ion issues, such leaders must be ruited from those people who are ective, competent, and have some sp of the scientific problems in- ved; they cannot just be emo- ial preachers of a "hot gospel." the past, the responsible leaders the old conservation were gener- produced by America's schools orestry (a contribution to Amer- n education usually ignored). ce the American university has n, in many cases, highly innova- and responsive to public need particular, the land grant col- s), the question arises as to re the leaders of the new conser- on will come from in the future, it kind of experts we will need, where they may be most ade- tely trained.

n the journal *Daedalus*, 1967 ie American Academy of Arts Sciences), several writers for a mposium of "America's Changing vironment" suggested that we d a new kind of trained expert lled by some "environmental nager"). No one, however, said y much about how they should rained and under whose auspices he university. They left the situ- on open to the typical (and often gically wasteful) response of erican higher education—creat- a new series of institutes or spe- departments.

he situation is somewhat similar what it must have been in city nning a few years ago. Everyone ognized the need for city plan- s, but no one wanted to integrate existing strengths and expertise he already established disciplines hin the university—law, sociol- , architecture, etc. As a result the versity, like some uncontrolled oeba, spawned a variety of titutes of city planning; along h this came an increase in inter- ine warfare between departments l often an unnecessary duplica- n of courses (e.g., urban sociol- y), a bewildering number of cer-

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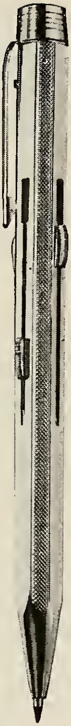

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tificates of certification (M.E.D., Master of Environmental Design; M.C.P., Master of City Planning; and M.U.S., Master of Urban Studies), and in some cases, a lowering of academic standards.

The construction of new academic institutes and departments (better called fortresses) is dandy for inflating academic budgets, creating demands for new buildings, and establishing homes for wayward scholars and erstwhile administrators. But can we afford this typical, free-wheeling, academic kingdom building when confronted with the problems of environmental contamination? I think not. The problem is already very much here and now, so we do not have much lead time. Also, because of the Viet Nam war and scientific commitments already made (especially in the federal budget), we must capitalize on the already existing human resources and institutions.

Another factor is that the schools of forestry and conservation in American higher education are already innovating curriculums and programs to meet the crisis. Furthermore, by history and tradition they are uniquely qualified to provide the kind of expertise needed for today's environmental problems.

For example, consider the Yale School of Forestry. Strictly a graduate school, it was founded in 1900 when Yale was already 199 years old, and embarked on a pioneering venture to train men for a profession—forestry—that did not exist on this continent. The Yale School has flourished and has survived to become the oldest forestry school in America. When the school was founded by Gifford Pinchot and Henry Graves, they made certain the curriculum emphasized the biological sciences while also stressing problems of management and economics. Thus there has developed at Yale a tradition as well as an institutional structure whereby the social sciences and biology are expected to work closely together. The Yale model became the prototype for most schools of forestry. Furthermore, because of the nature of forestry as a profession, the men working in it were forced to combine scientific knowledge with an ability to work with federal and state governments, and business. Traditionally, to be

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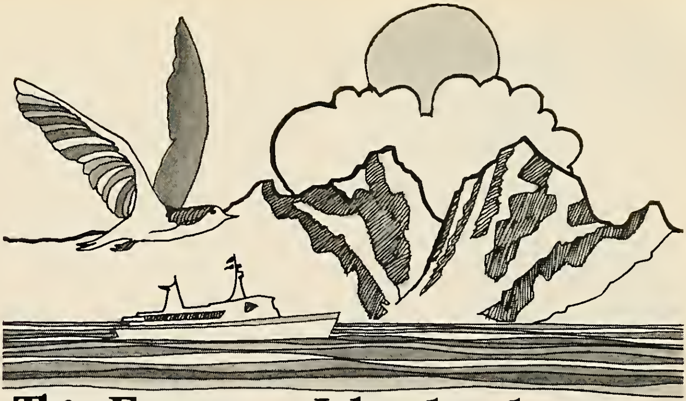
cessful, one needed to be a good anist, a zoologist. and a geolo- t, as well as a good administrator l politician. These are exactly the nbination of skills needed to meet : present environmental crisis, ich is itself caused by a combina- a of biological factors, sociologi- conditions, and administrative anglements.

A fourth factor encouraging the ergence of the new conservation he propaganda success of the old nservation. Public relations are *bête noire* of the American in- ectual. But public relations tech- ues may be used for worthwhile rposes. It is a fact that the nservationist movement has been cessful; today, to be "against nservation" is almost like being inst motherhood.

. have studied the content of pub- school children's magazines such *The Weekly Reader*. They are ed with stories concerning our ce program (propaganda straight m NASA) but they also give a pitch (and have for years) to nservation. There are many simple ries on animals, clean water, aning up the campground, and er traditional Boy Scout themes. his all sounds a little sentimental, me assure you that I do not look it in this way. When I think of child who may grow up to build endering plant on the river that is near my property, or who, en of age, will drill oil off the st of California and bring in big ges, I hope (perhaps fortuitously) t somewhere along the line he has l some exposure to conservation nking. In any case, the conserva- nists have been fairly successful vinning over the NEA groups and ularizing their ideas in the public ools.

Another indication of the success the message of the old conserva- n is represented in the field of ss communication. Perhaps the atest conservation propaganda cess of all time is to be found in nssie" and "Gentle Ben"—shown ry Sunday night on CBS-TV. nfortunately, we hear that "Gentle n" is to be discontinued after this son; let's hope that it will be re- ced with a show as pertinent to nservation interests.) One might ue that in the "Lassie" show the rest Service has involved itself in



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There are other signs that the traditional conservation movement has been relatively successful in making the general public aware of the need for conservation. The recognition of the general problems of pollution and environmental degradation are, however, speeding up this communication process and spreading an awareness of public issues to new segments of the population—as in the case of black power. Thus the new conservation builds on the achievements of the past but extends itself, as a nascent social movement, into the realms of democratic participation and the new science of ecology. It continues the valuable tradition of conserving the world of nature; but carries the process into another social and political realm. It deals with a new metaphysics, a new view of the world that, based on the science of ecology, forces the conservation movement into a much more critical stance vis-a-vis the culture (industry, social change, etc.) than was true of the past.

Briefly, the ecological concept stresses that the human environment is a complex web of interacting variables, and many of these variables are the facts of the natural world (biological and physical). Thus a change in one factor (for instance, bad air) has ramifications throughout the human environment—both biological and cultural effects. Furthermore, if one understands the connections, or pathways, of the system (energy changes), one may be able to predict over-all results of c tain social actions (such as putti more DDT into the environment)

Some of the recent activities the new conservation groups ha come from the leadership of scie tists and other specialists. For e ample, the Environmental Defen Fund of New York has (in Michig and Wisconsin) been sitting in fe eral and state courts to establish t right to a clean environment. Th have focused on the use of ha pesticides in the environment (f instance suing in Michigan cou to discontinue spraying the Dut elm with DDT). Other groups, su as the Committee of Scientists for Quality Environment in Connectic which was established to protect t marshlands of the Connecticut sho have been formed by leading ecol gists and although founded by pr fessionals, they have received co siderable public support.

Such efforts seem to engender th support. In Michigan there w widespread public reaction, almo all favorable, to the efforts of t Environmental Defense Fund. O of this has come, in several comm nities in the state, the spontaneo organization of local environment action groups.

In Grand Rapids, Michigan city of 200,000), an environment action program was started, linki ecological scientists and the publi With the support of local busines labor unions, and newspapers, a Environmental Information Cent was set up for western Michiga pressure was exerted on the Sta

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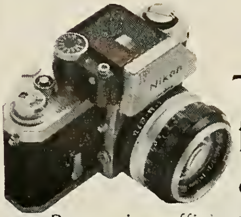
City__________ State__________ Zip Code__________ use (the governor appointed a mmittee to study pesticide use Michigan) and on local business give attention to water and air lution. A campaign also was nched to inform the public on danger of accumulating hard ticides in the environment. Atding some of the original meets of this group, I was impressed the enthusiasm and widespread cern shown by the Grand Rapids anization and the people inved. The truly striking thing, vever, and a point corroborated a survey of community leader- and general households, is that cern with the issue of the enonment seems to cut across the al sociological dichotomies. This especially evident in the political lm where people, ranging from ner conservative to liberal orienons, could join forces and work ether on local environmental iss. I was also impressed by the le range of occupations, from rking man to professional, that ponds to this issue (as the sociolo- would put it, the issue seems to across class lines).

Thus, after three years of studying zen conservation groups in the dwest as a participant observer—nding hundreds of meetings, lis- ing to discussions, and conduct- informal interviews—I am deeply pressed by several aspects of the v conservation. One is, of course, strong moral sense. Sociologically aking, if social thinkers from ile Durkheim to Talcott Parsons correct that a public acceptance underlying social values is essen- for maintaining social order, n the emphasis on moral indigna- n characteristic of many partici- nts in the new conservation is an portant fact. Secondly, if a poli- of consensus is somehow impor- t—in order to keep the social ucture functioning—then it is of ne interest that on this issue it is sible for extreme conservatives l liberals to work together. The itics of confrontation and conflict y not be the last word. There may and I consider this a hopeful n, many areas of agreement in erican political life that trans- d the current issues of confronta- n, and give some hope for a sense common purpose and a more live country. ☐



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Polynesian Surfing

by Ben R. Finney and James D. Houston

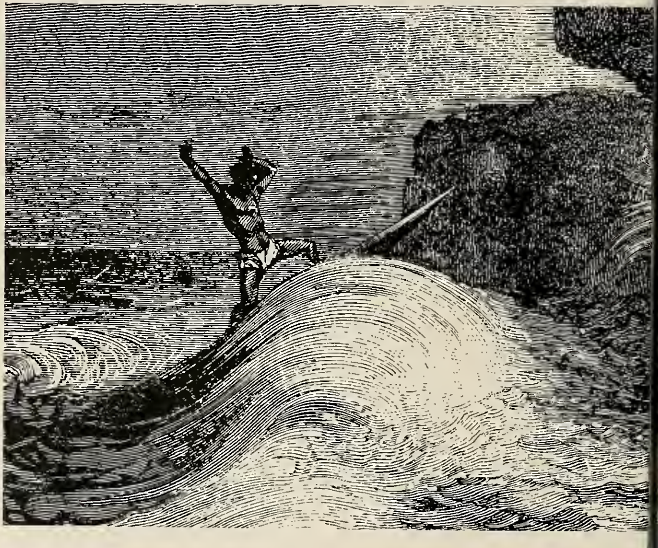
Riding the breaking face of an ocean wave has become an international sport enjoyed along surfable shores throughout the world. Surfers number in the hundreds of thousands and crowd the beaches from San Francisco to Biarritz. from Capetown to the North Atlantic coasts of Cornwall and Devon. Two hundred years ago this was almost exclusively a Polynesian sport, and among Polynesians the surfers of early Hawaii were clearly its masters. Today's worldwide surfing movement stems from the ancient Hawaiian sport, which in turn developed from a more rudimentary wave-riding tradition brought to Hawaii by the first Polynesian settlers of a thousand or more years ago.

All surfers, ancient and modern, have had at least one thing in common: the waves they ride. And whether or not a wave is ridable depends on the right combination of ocean swell and shoreline configuration. A gradually sloping beach, an underwater reef close to shore, and the interference of a jutting headland usually produce the best waves—those that rise steeply, but break with a regular curl and leave an open shoulder in front of the moving break so a surfer can ride free of white water.

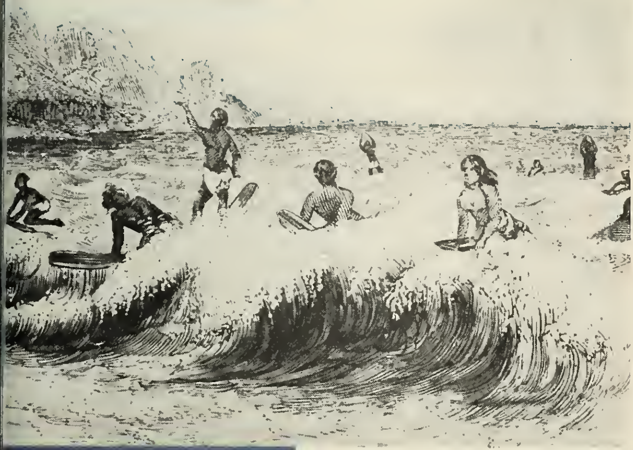
Three main ways have been developed to ride such waves: by swimming to catch it, then body-surfing down the slope; by paddling a canoe so that it slides in front of the breaking wave; and by using a surfboard. Surfboarding is the most popular, spectacular, and exhilarating, and is the form we're most concerned with here. Kneeling or lying prone, the surfer uses his hands to paddle into position. Just before it breaks, he paddles with the moving wave until he has enough speed and the wave's slope is critical enough for him to slide free. The surfer then stands and maneuvers his board with body weight and footwork, holding to the wave's breaking edge or darting in and out of its foamy shoulder as he rides toward shore.

The first step in the developmen of this form of surfing was probably the discovery that a stray plank and an ocean wave made a handy way for a swimmer to get back to shore. This in turn may have led to the simples form of surfing—belly boarding—using a short board held against the belly or chest to ride a wave prone This form was well known on many Pacific Islands, from New Guinea to Easter. It was also developed by water-loving people along the coas of West Africa. from Senegal to Nigeria, in the only example we have of wave riding as a popular recreation anywhere beyond Oceania before the nineteenth century.

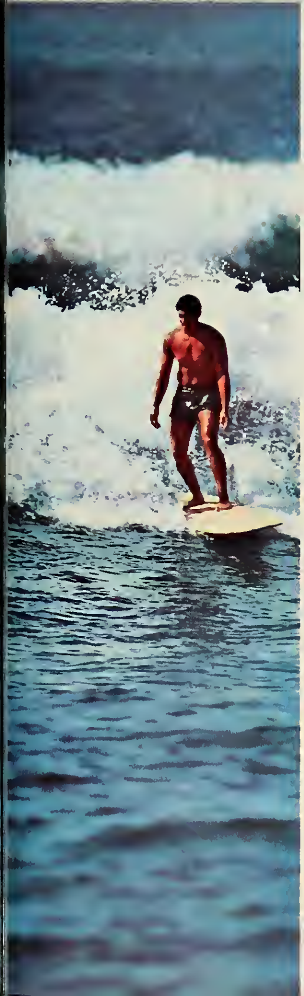
In most of Oceania it remained a simple sport. In Micronesia and Melanesia, for example, it has been mainly a children's pastime. It was



A mid-nineteenth-century artist's impression shows a Hawaiian riding the surf to shore. A modern surfer is at far right.



Before the puritanical influence of missionaries took hold, "surf playing" was a Hawaiian national pastime, enjoyed by men, women, and children. Often whole villages would spend all day in the surf.



among the major islands of East Polynesia—New Zealand, Tahiti, the Marquesas, and Hawaii—that surfing became something more than a casual recreation. Among these islands longer boards were developed and adults did much of the surfing. And among the surfers of eastern Polynesia, the Hawaiians led the way. There the finest boards were built, the riding of waves was a highly respected skill, and the sport itself was a vital element in Hawaiian culture—which helps to explain why the sport survived there, though barely, while it died out in other Pacific island groups during the nineteenth century.

Why surfing blossomed in Hawaii is open to conjecture. The islands have some of the finest surfing conditions in the world. Many surfers would say *the* finest. They are directly in the path of strong ocean swells from both the north and south Pacific, so that good waves break there year-round, fanning south from northern storm centers during winter months, rolling up from southern storms from June to October. The coastlines, moreover, are dotted with beaches, coral reefs, and headlands that focus these swells into ideally surfable waves of every shape and size. Perhaps this in itself explains why the early Hawaiians channeled so much of their energy into wave riding.

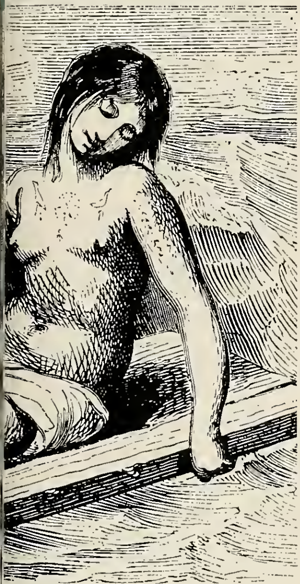
In any event, having arrived in these islands from the Marquesas about A.D. 750, they had developed a sport that was in full flower when Captain Cook first sailed up the Kona coast in 1778. Hawaiians were then using surfboards of several kinds. They rode them prone, kneeling, or standing up, and moved with ease across the slopes of waves, turning and twisting to get the best possible ride. Their skill moved Lt. James King, of Cook's expedition, to exclaim in the first published account of Hawaiian surfing, "The boldness and address with which I saw them perform these difficult and dangerous maneuvers was altogether astonishing and is scarcely to be believed."

Other early observers were equally impressed by what they called the Hawaiians' "favorite amusement," "national pastime," and "national sport." According to one missionary, their love of it was such that when the ocean offered a sudden run of good surf, "daily tasks such as farming, fishing, and tapa making were left undone while an entire community—men, women, and children—enjoyed themselves in the

sing surf and rushing white water." The finely made Hawaiian boards, few of which survive in museums, ere shaped from the trunks of cal trees with stone adzes, coral rapers, and other pre-Iron Age ols. Koa wood, from which canoe ills also were made, and the lighter iliwili wood, used in making canoe itriggers, were favored for surfard construction.

The boards were divided into o main types: the *alaia* and the o. *Olo* boards were long, thick, and oyant, while *alaia* boards were orter, much thinner, and probably uld not fully support a rider until e board was planing on a wave. An erage *alaia* board would have been out eight feet long, eighteen inches ide, and an inch or so thick. The ose was wide and rounded, and the de rails tapered to a squared-off il. Although some observers reorted *olo* boards twenty-four feet ng, most were probably in the urteen- to eighteen-foot range. The oard surfed during the 1830's at Waikiki by the Hawaiian chief Paki, and now on display at the Bishop Museum in Honolulu, is probably a representative *olo* type. It is nearly sixteen feet long, over eighteen inches wide, six inches thick, and weighs about one hundred sixty pounds. Like the *alaia*, both decks are convex, but its thickness and length give the *olo* a long cigar shape, compared to the planklike *alaia*.

Highly maneuverable, *alaia* boards were good for catching steep, fast-breaking waves. Even though they lacked the tail fin considered essential on modern boards, the *alaia* boards could be easily turned and ridden at an angle across the wave. An eyewitness to a Hawaiian surfing a seven-foot board at Hilo in 1878 describes a typical *alaia* ride: "One instantly dashed in, in front of and at the lowest declivity of the advancing wave, and with a few strokes of the hands and feet established his position; then without further effort shot along the base of the wave eastward with incredible velocity . . . his course was along the foot of the wave, and parallel to it . . . so as soon as the bather had secured his position he gave a spring and stood on his knees upon the board, and just as he was passing us . . . he gave another spring and stood upon his feet, now folding his arms on his breast, and now swinging them about in wild ecstasy in his exhilarating ride."



This surfing beauty was sketched by Jacques Arago in Hawaii about 1819. After the arrival of the missionaries and the ensuing increase in modesty, scenes like this were seldom seen again — apparently until recently.

Olo boards were designed for massive but slower-breaking surf and for getting long rides. Their length, narrowness, and buoyancy enabled a rider to paddle fast and catch a wave well before it became critical enough to break, and to ride it all the way to shore even though it may have crested and lost most of its force. *Olo* boards were thus ideal for the long-breaking surf at Waikiki Beach. But their bulk made quick turns and maneuvers difficult, so they were not suited to rocky beaches and fast-breaking waves. Since most of the Hawaiian surfing areas were of this latter type, it is not surprising that *alaia* surfing dominates early accounts of the sport, and that most of the ancient boards remaining—ten of thirteen in the Bishop Museum collection—are of the *alaia* type.

This distinction between *olo* and *alaia* also figures in Hawaiian social structure. Commoners (*maka' ainana*) and chiefs (*ali'i*) were rigidly divided, and it appears that the *olo* boards were exclusively reserved for the chiefly class. In addition, there is evidence that chiefs could reserve waves for their own pleasure and taboo a surfing beach to commoners. *Alaia* boards, on the other hand, were used by chiefs and commoners.

Chiefly privileges in surfing were accompanied by expertise, for chiefs were known for their surfing prowess. King Kamehameha, the high chief who conquered all of Hawaii and founded a dynasty in the early years of European contact, was particularly famed for his ability as a surfer. Instruction in surfing was part of a young chief's upbringing, and the strength and stamina derived from this and other aristocratic sports, such as canoe racing and spear handling, was undoubtedly one of the objects of the training. In addition to their own type of board, their own surfing instructors and expert board makers, Hawaiian chiefs also had special chants in which their surfing exploits were celebrated. Even King Kalakaua, the last king of Hawaii, had his own surf chant, one he appropriated from the chants of an earlier high chief who had surfed Hawaii's waves long before Captain Cook arrived.

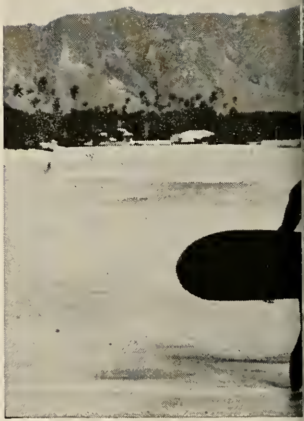
Another measure of surfing's role in the life of these islands is its frequent mention in the legends that make up Hawaii's rich heritage of oral literature. These provide one more source of information to supplement the reports by early visitors and mission-trained Hawaiian scholars who wrote about their culture. That Hawaiian women were active surfers is confirmed by the many legends mentioning female exploits in the surf. The role of surfing in courtship also stands out in these tales. The legends tell of many a chief who is first attracted to his wife through watching her perform in the surf, and frequently a young surfer shows off in front of his favorite, hoping to win her hand.

Legends reveal the importance of competition among Hawaii's surfing chiefs. Contests, in fact, were a large part of the game. And the wagering on such matches, by contestants as well as spectators, was a favorite and often fanatic pastime that could overshadow the sport itself. Hawaiians were inveterate gamblers, known to bet everything, down to the last article they possessed. Overcome by the excitement of a surfing contest, a chief might wager canoes, fishing nets and lines, tapa cloth, and sometimes his own life or personal freedom on the outcome of the match.

The seriousness of this kind of competition is illustrated by the legendary match between Umi-la-liloa, a chief of ancient Hawaii, and Paiea, a lesser chief. As a young man Umi attended a surfing match where Paiea challenged him. The wager was so small that Umi refused, so Paiea raised the bet to four double-hulled canoes. Umi accepted, handily defeated Paiea, and won the canoes. But during the match Paiea's board clipped Umi's shoulder, scratching off some skin. At the time Umi did nothing about it. Later, though, when he came to power as high chief, he had Paiea sacrificed to his god.

Like just about everything else in ancient Hawaii, surfing also had its sacred aspect. The making of a board, from the felling of the tree to the initial launching, required appropriate rituals to placate or invoke certain spirits and deities. Among the roots of a felled tree, for instance, a board builder would place a red fish, with a prayer, as an offering to the gods in return for the tree he was about to shape into a surfboard.

By the end of the nineteenth century, when this photo was taken, surfing was at its lowest ebb. This lone Hawaiian surfer at Waikiki Beach carries one of the last alaia *boards to be ridden there. Note the lack of hotels below Diamondhead.*



There is even evidence that surfing had its own *heiaus*, or stone temples. Two of these were still standing in the early 1960's, the *Kuemanu* and *Keolonahihi heiaus* on the south Kona coast of the island of Hawaii. Although how these temples were associated with surfing is not entirely clear, it is notable that both structures stand opposite well-known surfing breaks and were probably fine sites for observing the surf, for resting after surfing, or even for invoking the waves. *Kuemanu heiau* consists mainly of an upper stone terrace on a larger foundation. A deep, stone-lined water pool is sunk into one side of the foundation terrace, ideal for bathing or for rinsing off salt water. The terraces themselves are so aligned that from the upper level, which is like a bleacher, spectators might easily watch surfers riding waves less than a hundred yards away.

Although it is not specificall associated with these *heiaus*, on Hawaiian surf invocation has su vived in the literature. When th ocean was flat, surfers waded i carrying strands of the *pohuehu* vine (beach morning glory), an striking the water with them, the would try to call up some ridabl waves by delivering this chant:

Arise! Arise! Great surfs from
Kahiki,
Powerful curling waves, arise
with the Pohuehue,
Well up, long-raging surf.

Such was surfing's p sition in Hawaii when the first e plorers came, but by the end of t nineteenth century, the sport had a most completely disappeared. Th reasons for this are of a piece wit the decline of Hawaiian culture as whole: the general impact of Wes ern civilization, which seduced th islanders away from traditional hal its; the drastic drop in Hawaiia population—from 300,000 to 40,00 in one hundred years—due to diseas and social disruption; the arrival

hristianity to replace the old reli-ion; and the repressive dictates of issionaries who discouraged gam-ling, men and women swimming gether, exposing one's body in ublic, and the general frivolity and me wasting that went along with opular pleasures like surfing.

By the 1890's observers were ourning the sport's decline. "There re those living," said one, "who emember the time when almost the ntire population of a village would t certain hours resort to the seaside o indulge in, or to witness, this agnificent accomplishment. . . . But his too has felt the touch of civili-ation, and today it is hard to find a urfboard outside of our museums nd private collections."

Surfboards did take their place in useum collections, alongside other awaiian artifacts of activities now orgotten. But surfing didn't die. Of ll the traditional sports and pas-imes, it fared best. Most of the thers quickly disappeared early in he period of foreign contact. As the wentieth century began, surfers ould still be found in the Waikiki rea of Oahu. But almost none of the ormer style and plumage remained. one were the chants, the contests, he wagering, and the chiefly privileges. The regal *olos* were no longer being constructed. The boards in use were crude copies, about six feet long, of the old *alaia* boards; many were hardly more than roughhewn planks. And only a handful of surfers remained to ride them.

During the nineteenth century few outsiders had learned how to handle a surfboard. Mark Twain, while visiting Hawaii in the 1860's, remarked, "None but the natives ever master the art of surfing thoroughly." A popular myth held that only a Hawaiian could ever stand and balance successfully on a moving board. The first sign of surfing's revival came when, soon after 1900, a group of Honolulu residents, including several eager schoolboys, challenged this myth. They rediscovered the waves at Waikiki, generating new interest in the ancient sport.

Among these new surfers was George Freeth, the Irish-Hawaiian who later brought surfing to America. Also prominent was Alexander Hume Ford, a mainlander so taken with the sport he became its key promoter. Ford conducted surfing classes at Waikiki, where his most famous pupil was Jack London. In 1907, during his cruise on *The Snark*, London spent several weeks in Hawaii and camped for a while in a tent on Waikiki Beach. He became one of surfing's most outspoken boosters.

Just as this revival was getting under way, it was threatened by hotels and new private residences along Waikiki Beach, which began to close off the beach front to surfers. Under Ford's leadership several enthusiasts formed a group to protect surfers and to promote the sport as a pastime and as a tourist attraction. About this time, Jack London's impassioned article, "The Royal Sport," in a national American magazine, heightened interest in surfing, not only in Hawaii but on the mainland as well. Aided by this and other publicity, Ford's group acquired an acre of beach-front property in 1908 and founded the Outrigger Canoe Club, for the purpose of "preserving surfing on boards and in outrigger canoes." It was an unprecedented move. The club became the world's first organization whose stated mission was the perpetuation of wave riding. A Hawaiian surfing club, the *Hui Nalu* (literally Surf Club) was founded soon thereafter, and rivalry between the two helped foster the revival. By 1911 as many as a hundred surfboards could be seen at Waikiki on a weekend.

Once revived at Waikiki, surfing thrived not only in Hawaii but along other Pacific coastlines visited by Hawaiian surfers. In 1907 George Freeth came to southern California as part of a promotion venture sponsored by a railroad company to introduce water sports to a public whose interest in ocean recreation was just starting to grow. Freeth gave wave-riding demonstrations, offered classes, and began the exchange between Hawaii and California that has in recent years become the greatest source of energy in the sport's rapid postwar expansion.

Five years after Freeth, Duke Kahanamoku passed through California on his way to the 1912 Olympics. At the time Duke was one of the world's fastest swimmers and, like Freeth, a leading Waikiki surfer. His performances at such now familiar surfing spots as Santa Monica and Corona del Mar greatly encouraged the growing body of surfers there. With ridable waves coming from the north and south Pacific, numerous beaches and headlands to shape inviting surf, and a blossoming interest in outdoor living, California provided the ideal environment for the first successful transplant of Hawaiian surfing.

Meanwhile, down below the Equator another world of surfing was coming to life. In the late 1800's a South Sea islander had taught some Australians how to body-surf waves without a board. Soon after the turn of the century tales of Hawaiian surfboarding trickled south to Australian shores. Stimulated by this notion, several body-surfers around Sydney tried to make their own boards, but with little success. Their crude planks were failures. Even a surfboard imported from Hawaii in 1912 proved impossible to ride. Australian surfers needed an example. They soon found one in Duke Kahanamoku, who arrived in 1915 to give swimming exhibitions. While there he built a board from local wood and gave Australians their first look at Hawaiian surfing. And from there the sport soon began to spread in Australia. much as it did in California. But with a major difference. It quickly became integrated with a lively organization later to be called The Surf Life Saving Association of Australia. And during the past fifty years, as the SLSA spread to other countries in the British Commonwealth, surfing has gone with it—to South Africa, to England, and, ironically, back to New Zealand, to revive a long-dead pastime there.

The subsequent spread of surfing around the world has generated from these three areas—Hawaii, California, and Australia—most of it during the past ten years. Improved world travel and communication, increased leisure time, and a growing worldwide interest in water sports all help to account for this growth. But perhaps the most important factor has been the development of the light, mass-produced surfboard made of plastic foam and covered with fiber glass.

Prior to the 1950's surfboards were heavy, cumbersome "planks." They were made of redwood or redwood and balsa strips, or they were "hollow boards" made with watertight compartments of plywood. Both these types derived from ancient Hawaiian boards, but differed in design features as well as in performance. The plank was descended from the crude *alaia* copies being used at Waikiki at the beginning of surfing's revival. By the 1940's, after several design changes, the plank had lost most of the fine features that distinguished the *alaia*. Measuring eleven to twelve feet in length, some two feet wide, and three to four inches thick, the plank had become a massive board, resembling the *alaia* only in its basic outline.

In an attempt to re-create the fast paddling and long-wave riding features of the ancient *olo*, hollow boards were developed during the 1930's. These boards survive today as lifesaving aids at lakes and ocean beaches. They were usually fourteen to sixteen feet long, at least four inches thick, and close to two feet wide. They differed from the planks most radically in their tail design, which tapered to a point, makin them fast paddlers. Both boards wer heavy, weighing from sixty to on hundred twenty pounds or more, an hard to handle. Learning to surf wit one of these boards usually too months or even years, which discouraged many prospective surfers

In the late 1940's Californians began experimenting with surfboard made of light balsa wood covere with a protective layer of fiber glas and resin, and they added a tail fi to improve stability and turning. Th result was a board about ten fee long, weighing only twenty to thirt pounds. It revolutionized surfing. I was light, buoyant, easy to learn on and allowed surfers to perform maneuvers never imagined with th ponderous planks and hollow boards California surfers introduced thes new boards to Hawaii, Australia, an New Zealand, where they were labeled "Malibu boards," after th famous southern California surfin beach. The balsa board soon becam readily available from surfboar shops that sprang up around th major surfing areas, and it greatl popularized the sport. Within a fe years old-time surfers were complaining of the "log jams" at thei favorite breaks. They had more t complain about when, after surfin was featured in several Hollywoo

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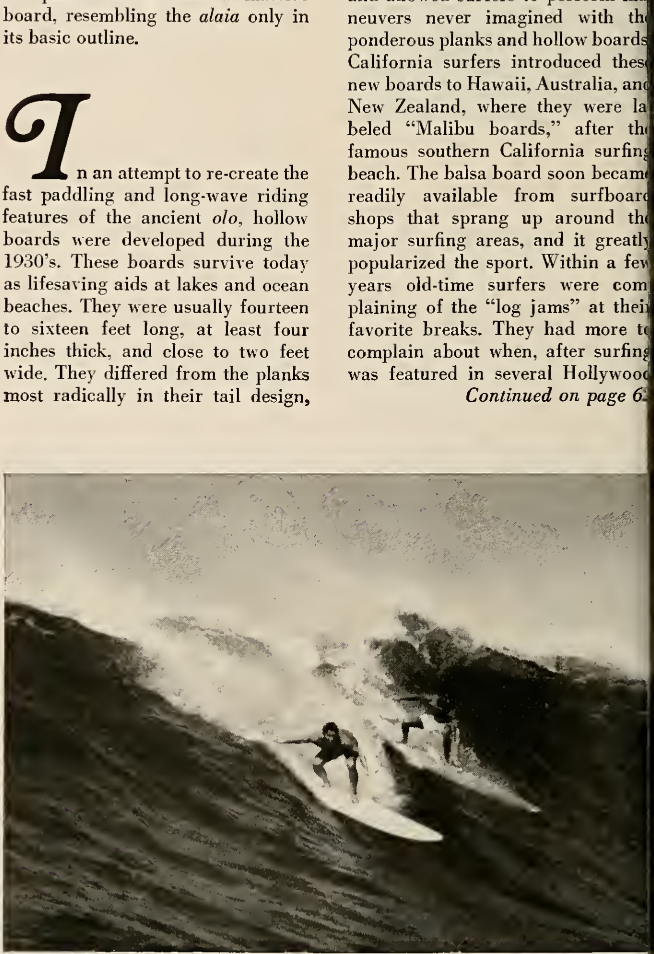
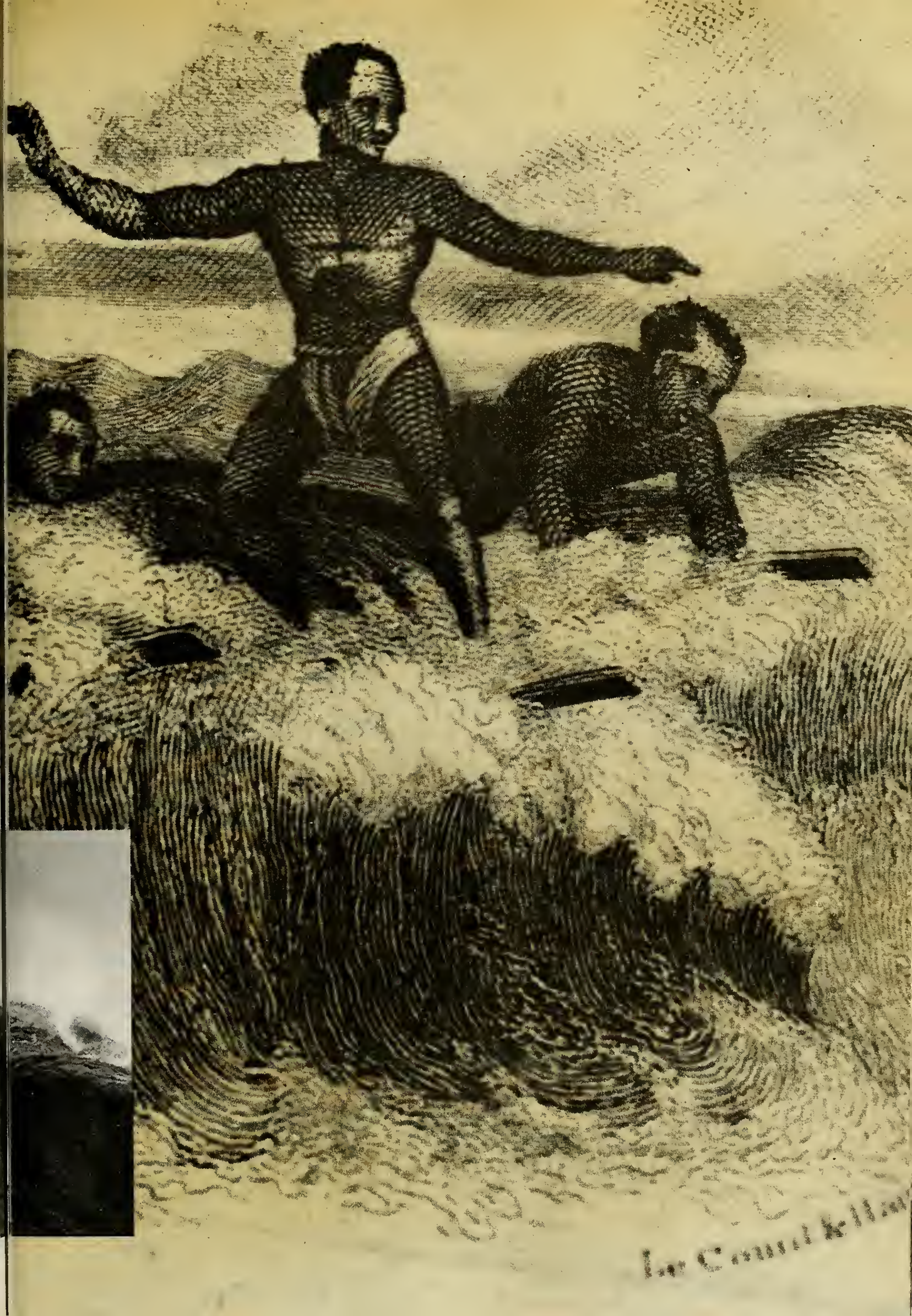


The first-known drawing of a man riding a surfboard is shown at far right. It was published in 1831 in William Ellis's Polynesian Researches.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The Gecko Grip

by Joseph F. Gennaro, Jr.

On hearing a familiar croaking cry a Malayan youth might look up toward the ceiling and see a brightly colored lizard—pastel green and orange—of extraordinary locomotor ability. It is *Gekko gecko*. Even upside-down, this animal can move rapidly along polished or rough wooden surfaces, plaster, concrete, or glass without the slightest hesitation and with no apparent fear of falling. Just how does this strange climber maintain its grip? The boy might then get a pole and try to knock the lizard down—not an easy task since the animal can hold on, even to glass, with only one foot. Should he succeed in catching it, he might wonder at the way its feet cling to his hand or skin.

What feels like a considerable suction force is being exerted, not by suction cups like those on the toes of some frogs, but is instead associated somehow with the chevron-shaped ridges, the lamellae, across each toe. Close examination shows that these horizontal lamellae are brushlike and composed of tiny bristles. Each toe ends in a small claw, although the claw itself does not seem necessary for holding on. Furthermore, there is no sticky material to account for the adhesion; the toes, like the rest of the reptile's skin, are sleek and cool to the touch.

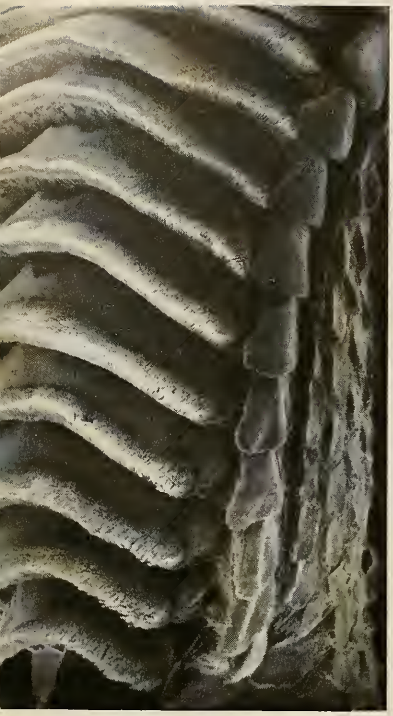
Incredibly enough, at this juncture the boy—whether he lets the gecko go or, as some authors have said, torments the animal and passersby alike by attaching a string to it and lowering it from a roof onto pedestrians' hats to snatch them off—would be in possession of almost all the obtainable basic knowledge of the gecko's clinging method.

Some of the earliest herpetologists pondered the problem of the gecko's grip. They reasoned, almost a priori, that a suction device of some kind must be involved. It was only when the light microscope failed to detect any such structure that other hypotheses were developed to account for the "stickiness." One of the more unusual and informative investigations was carried out in 1949 by the German zoologist W. Dellit. Having accepted the limitations of the optical techniques available to him, he undertook some original observations and experiments. They followed from his analysis of the structure of the animal's limbs and the way in which they worked. Dellit noted that the gecko can bend its toes backward (inset photo, page 36). In this action, which produces a reverse fist, each toe curls much the way a section of peel comes off a banana. The toes bend this way automatically each time the gecko removes a foot from the surface. Dellit then studied the digital bone structure and the joints between the bones, observing the special characteristics of the joints that permit this bending movement. He also observed the special arrangement of the tendons of the flexor and extensor muscles of the appendage. In the gecko the extensor muscles, which open a hand or foot. are attached to the upper surface of the skin at the toe's end, where the lamellae begin.

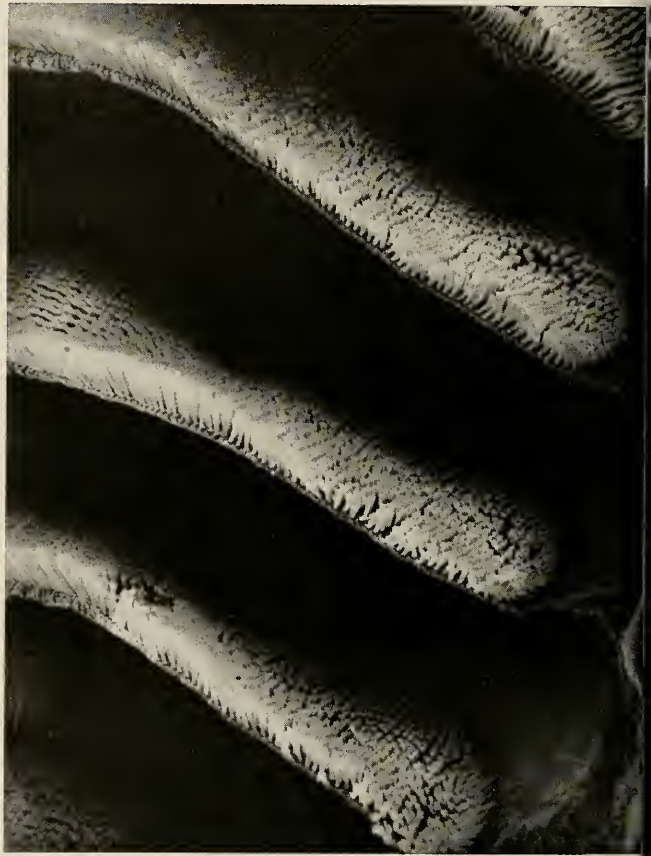
When the extensor muscle contracts, these lamellae fan outward and the special arrangement of the joints permits each toe to be rolled backward, like a window shade or the banana peel. On the bending side, the flexor muscles—those that bring the digits together to produce a "pinching," or grasping, grip—are attached to the base of the pad of bristle rows. Such attachment means that when the flexor is pulling, the toes exert pressure on any flat surface to which the gecko is clinging.

Surprisingly, the muscle action is so positive that an animal's amputated foot can be made to adhere to a glass surface simply by fastening a weight to the tendons of the flexor muscles. With the weight pulling the flexors, even an amputated limb will not release the surface. Only when the extensors are pulled do the toes curl back. permitting the limb to become unattached.

But what of the adhesive mechanism itself? To learn whether or not the grip depends on suction, Dellit tested the grip of the same foot in a vacuum with a one-gram weight hanging from the flexor tendons. The limb remained firmly fastened to the glass surface. Certainly, Dellit rea-



From left: at relatively low magnification (30 X) the clinging surface of a gecko toe is seen as a pattern of chevron-shaped lamellae; at 90 X the scanning electron microscope demonstrates its great depth of field while examining three lamellae for more detail; another tripling of magnification reveals the lamella's array of brushlike setae, each able to move independently of its neighbors.



soned, this experiment proved that some means other than suction was responsible for the adhesive force.

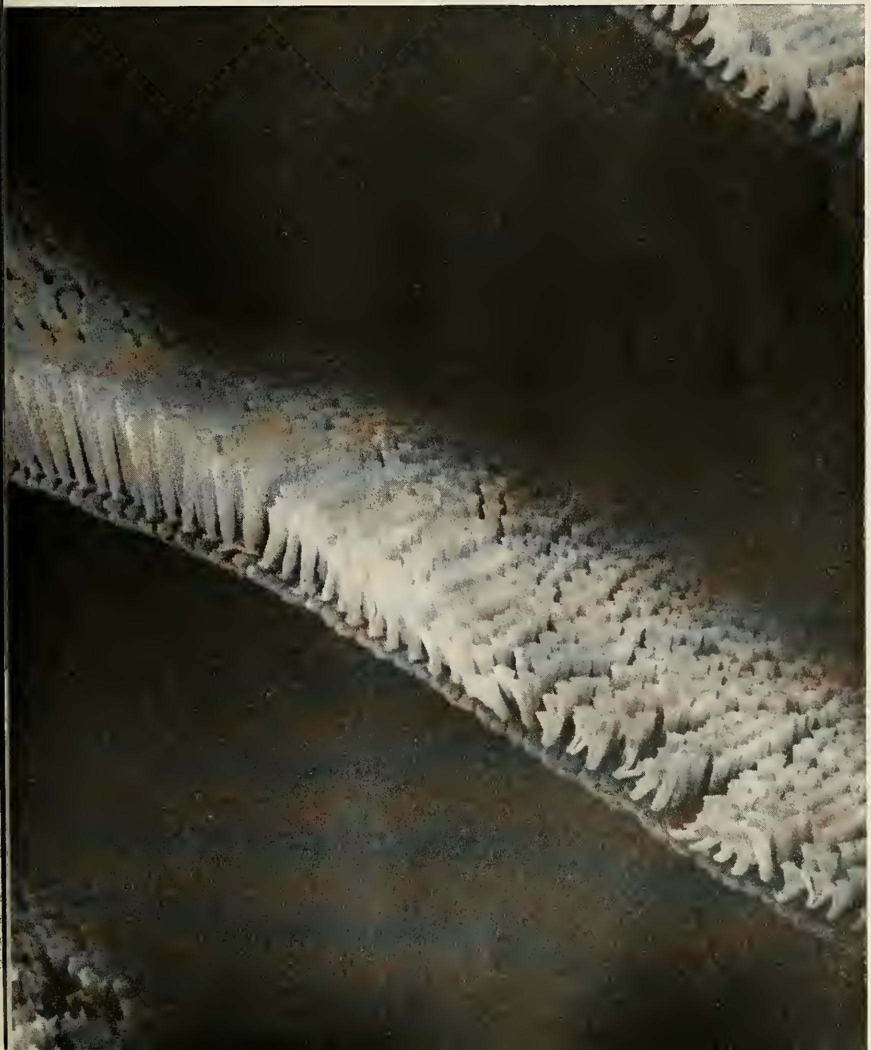
His work proved to be a potent obstacle to the "suction cup" theory. Even when the toes of these animals were examined with the transmission electron microscope—which yields profile images, or silhouettes—the data was interpreted as indicating the existence, not of suction cups, but of bristles, many times subdivided, on the ends of the brushes making up the lamellae, which are visible to the naked eye.

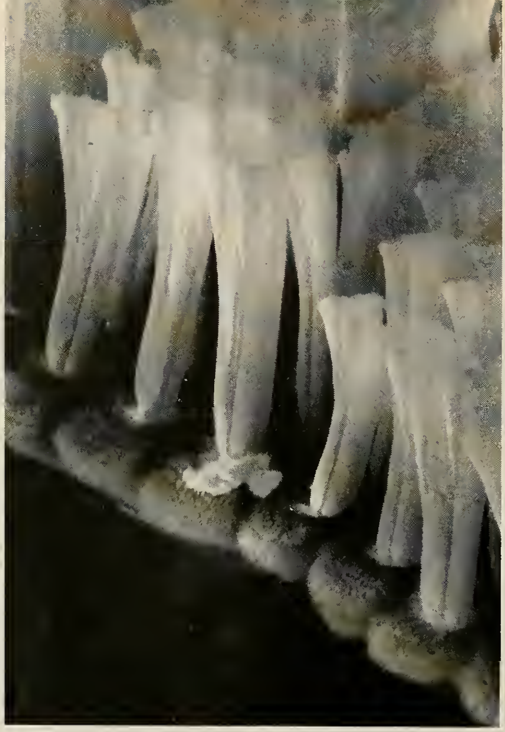
Obviously, further information could only be obtained through the use of a completely new approach, or perhaps a new kind of instrumentation that would permit visualization of the digital surface from very low magnifications through very high ones—so high that the observer could be sure that little or no significant biological structure existed beyond what he could see. This would require magnifications several thousand times greater than those available with the light microscope, and greater resolution as well. These two requirements, extreme magnification and resolution, call for the kind of microscope that uses an electron beam as its source of illumination. An additional advantage of this electron source is greatly increased depth of field. But for studying surfaces, the images produced by the usual (transmission) electron microscope are difficult to interpret. What is r quired for surface work is a speciall adapted electron microscope.

The scanning electron microscop is this kind of instrument. The un usual "three-dimensional" pictures i takes are now beginning to appear i scientific journals, each picture mor remarkable than the previous one, a techniques of preparation improv The instrument is still in its infanc yet there is hardly a phase of scienc to which it is not applicable, probably because its development has coincided with a period in scientific investigation during which surfaces, surface membranes, and surface structure have become critically important. Further, this instrument is the choicest one for observation of such areas. Not only can it operate with small amounts of material, but it can return four kinds of information in a single investigation. One can observe the following: light emitted from the specimen struck by the electron beam; electrons reflected by the specimen; secondary electrons, from within atoms of the object itself, knocked out by the primary electrons from the beam; and X-rays generated in the specimen by the electron beam. This instrument may be used for analyses of molecular structures as well as for microscopic viewing.

In this work, when we wished to obtain a detailed view of the surface of the lizard toe, it was unnecessary to prepare the specimen any further than to coat it very thinly with gold (evaporated onto the surface under vacuum); then observe the specimen in the microscope.

Except for their "frosty" appearance, the resulting electron micrographs look, at low power, as though they might have been taken with an excellent camera, possessed of an unusually fine lens giving critical detail and great depth of field. The rows of lamellae are easily seen, and one can visualize the strict geometric arrangement of the brushlike setae, which comprise the lamellae and present what are indeed suction cups to a surface. Each seta is seen mounted

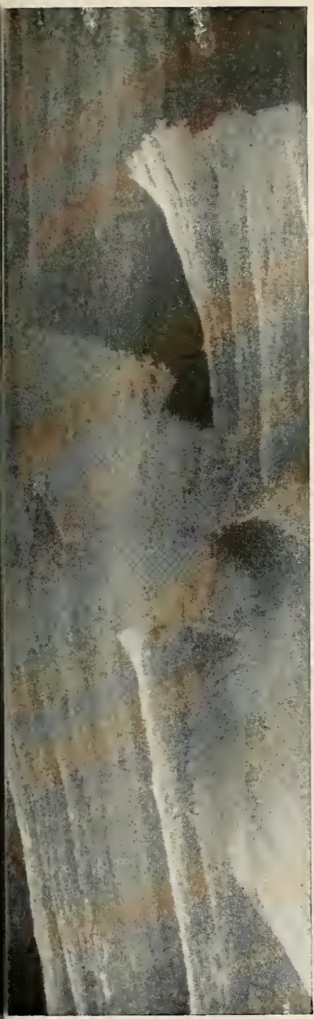




individually on a small bristly knob —an arrangement providing free movement of the seta with respect to its neighbors. At higher magnifications, the arrangement of the setae along each lamella resemble shocks of ripe wheat in a field. Each seta is double and the tips of each of these halves divide again several times. This pattern, visible in the light microscope, led the early microscopists to believe the setae are actually brushlike devices that catch in the microscopic irregularities of the substrate surface to which the lizard clings. If magnification goes beyond 2,000 diameters, however, it can be seen that each of the final divisions of the bristles has at its tip a small cuplike structure about 7.8 millionths of an inch (2,000 angstroms) in diameter, just beyond the resolution capability of the light microscope. Closer examination indicates that the cups probably have a thin border that can easily conform to irregularities of the substrate. Also interesting and, we believe, important, when the lizard wants to break its grip the cup is not attached perpendicularly to its terminal bristle. Each of the 2,000 or more cups per seta seems to be set on the end of its bristle at what might be described as a jaunty angle, unlike the rubber suction cup on the end of a toy arrow.

We were so intrigued by these observations that we also used the scanning microscope to look at the digits of the American lizard *Anolis carolinensis*—another outstanding clinger. Here also the existence of a suction cup had not previously been established. From the first low-magnification glimpse, the similarities and differences between the anole and gecko become evident. The anole also has lamellae, but its setae are less regularly arranged along the lamellae, and increased magnification shows that the setae are not branched. They stick up above the surface of the digit as single stalks, each bearing a single cup at its end. This cup is larger than that seen in the gecko—29 millionths of an inch in diameter—and attached to the stalks differently, not as a cup on the end of a stick, but as a gradual swelling on the end of a tapering rod.

Occasionally, particles of dirt can be seen adhering to the setae of the anole digit. It occurred to us that close observation of the relationship between the setae and the dirt particles could illustrate how the setae might attach to any substrate from which the lizard was suspended. From this kind of investigation two interesting observations were made. First, it appears that when the anole

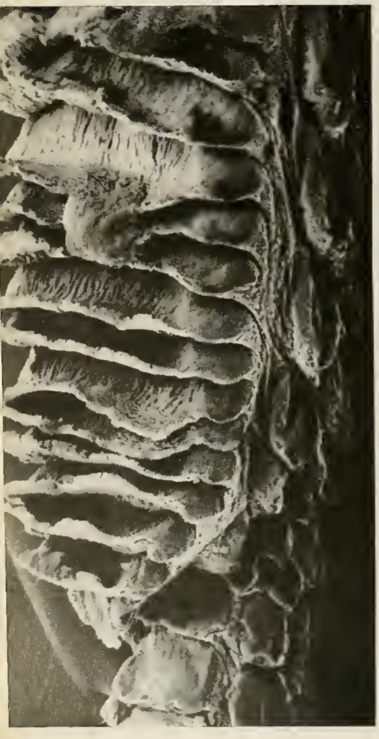


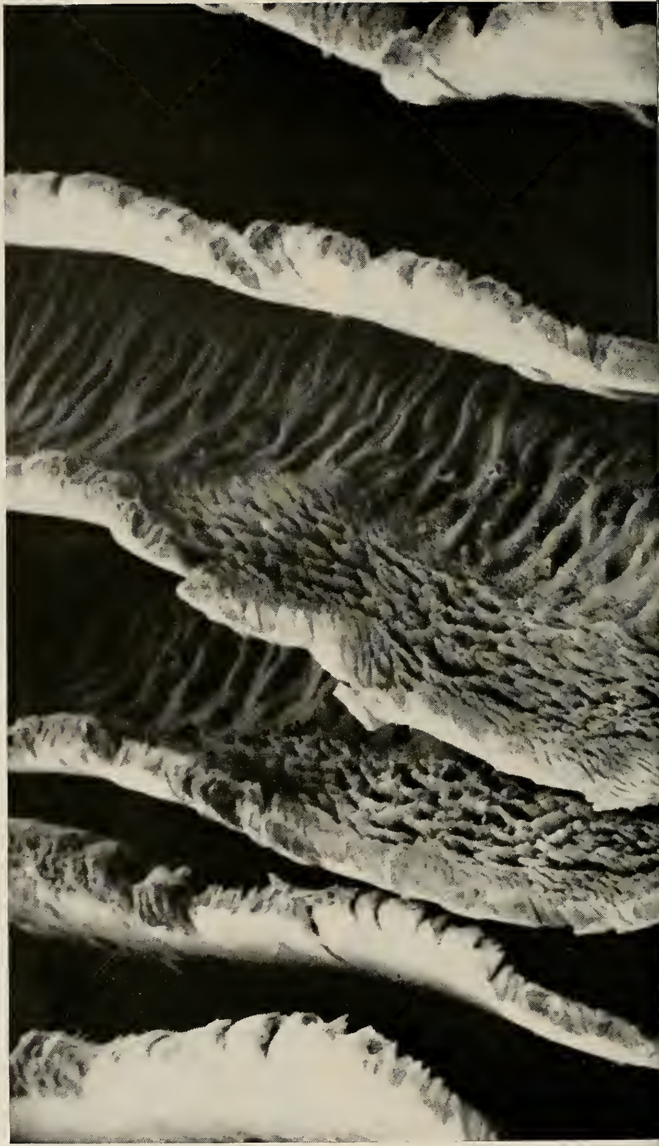
From left: at 900 X the scanning electron microscope shows each gecko seta is actually a double brush with fringed tip; at 4,400 X (more than twice the best magnification available with a light microscope) each fringe terminal reveals its attached suction cup; a fiber seen at much higher magnification (35,000 X) shows its double terminals and cups.

grasps a surface, its setae do so with the rims of the cups touching, so that the effect is similar to attaching a single large cup.

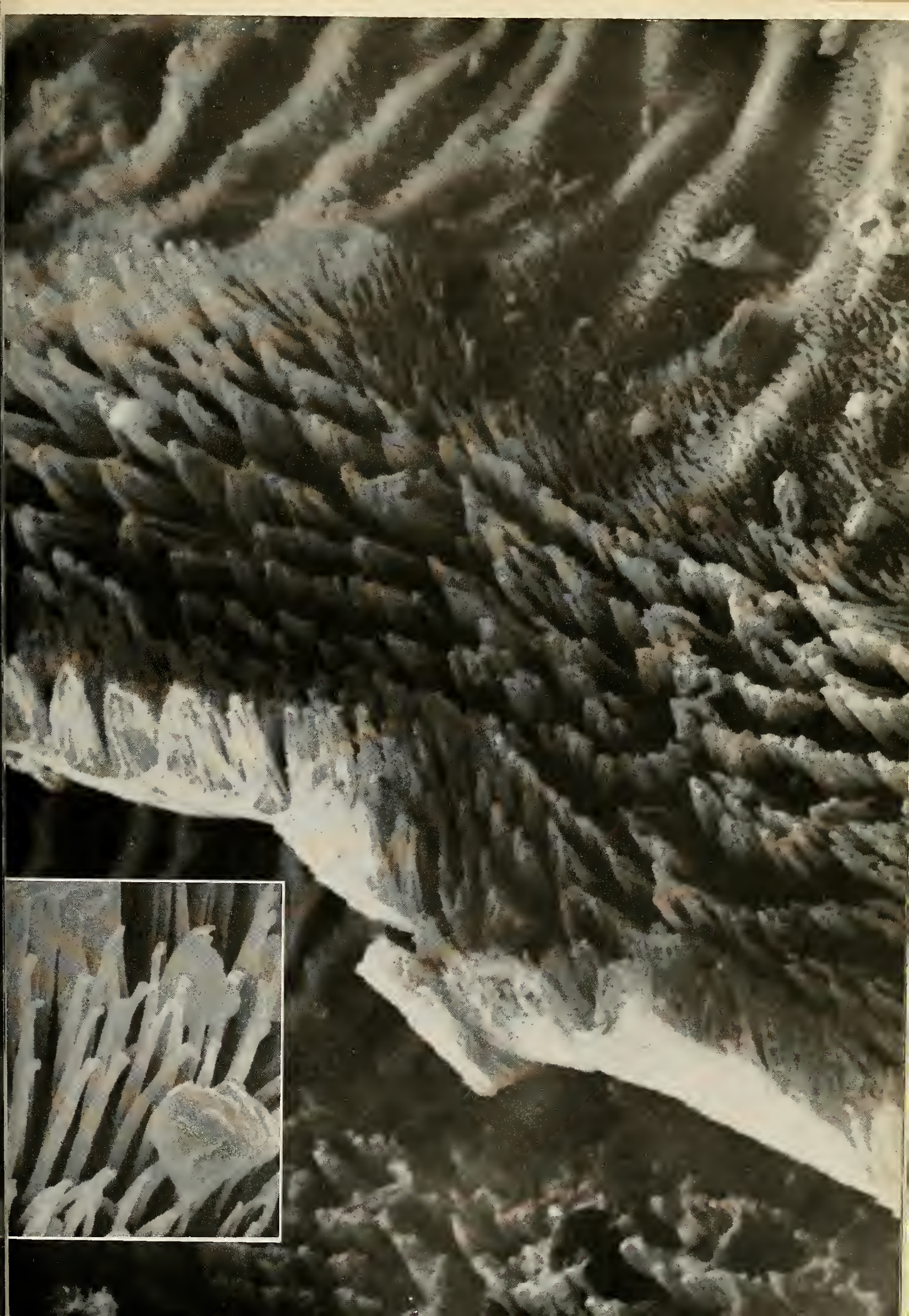
As in the gecko, the advantage of creating what is functionally a large cup from many smaller, contiguous ones comes from improving the "fit" on irregular surfaces. Perhaps because the anole cup is large, *Anolis* seems somewhat less agile on smoother surfaces than the gecko. Apparently, however, the anole setae are more flexible and can bend while the cup still adheres to a surface. The effect is almost as if each seta seizes the surface under its own volition.

No hypothesis accounting for either lizard's grip is of much value if the mechanism of release is not clear. Apparently, when the gecko rolls its toes back this both flattens the rows of setae and curls them up; thereby each seta terminal pulls on the cup in such a way as to raise it from the surface with relative ease. So, too, the anole evidently removes its foot from the surface in a manner that raises the edge of the more conical cup it carries on the end of each seta. Thus the scanning electron microscope has provided us with the answer to an old puzzle. Our observations are confirmed by those reported by other investigators. In retrospect, the only question that might remain involves a point of simple curiosity—as to why we found the feet of the American lizard to be dirtier than those of the Asiatic one.





From left: at 70 X, a toe of the American lizard (Anol
is crossed by rows of lamellae somewhat resembling those
the gecko; but viewing at 420 X reveals setae are loca
only along the edge of the lamella; at 1,550 X, the se
are clearly seen to be single, not brushlike, structures, ea
terminating in a relatively large suction cup (inset, 5,000



SKY REPORTER

SKY FULL OF MOONS Evidence is mounting that the earth may have had two moons until December 18, 1955, when one of them blew up, forming moonlets.

This second moon may have been seen as long ago as 1947 and perhaps again in 1952. Certainly no one saw the explosion in 1955, or this would not be a news story now, fourteen years later. But orbits have been computed for the fragments that have been seen since, and they all intersect on that same December 18.

John P. Bagby, a Hughes Aircraft Co. scientist who has been interested in the possibility of such moons for the last fifteen years, marshaled his arguments in a recent issue of the journal *Icarus*. He offers two kinds of evidence:

1. Direct observations. During 1968, he recorded magnitudes of about 7, not far below the limit of naked-eye visibility.
2. Indirect observations. Something is causing sudden shifts in the orbits of at least 55 artificial satellites. If the natural satellites came close enough, they could cause such shifts by gravity, electrostatic repulsion, or magnetic effects.

Bagby estimates the moonlets left by the explosion range in diameter from 8 to 35 yards. In some cases they would have to come within thirty yards of the artificial satellite to change its orbit; in others one mile is sufficient.

If they do exist, these new moons may not be alone. Three years ago Bagby offered evidence for another object circling the earth against the traffic (from east to west). Thirteen years ago Kazimierz Kordylewski first saw clouds of dust circling the earth in gravitationally stable positions 60 degrees ahead of and 60 degrees behind the moon.

ALL QUIET IN ARISTARCHUS The Apollo 10 mission last May was a great success for everyone concerned—except a worldwide group of astronomers hoping for conclusive proof that "transient lunar phenomena" really do take place. The transient phenomena are sudden color changes near a lunar feature. In many cases observers report a red cloud in or around a crater or geologic fault.

The flight of Apollo 10, to within 10 miles of the moon's surface, appeared an ideal time to catch one of these mysterious events in progress. NASA hired the Center for Short-Lived Phenomena of the Smithsonian Astrophysical Observatory to coordinate the earth-based part of the program. Amateur and professional astronomers around the world were asked to join in a watch that would keep the moon under surveillance at all times.

During six days of the mission the center handled 786 cables and telegrams from 176 observers in 31 countries, including one in mainland China. The watchers reported 23 separate transient lunar phenomena, 15 of them in the crater Aristarchus. Word was quickly passed through Mission Control in Houston to the astronauts. They looked, looked again, and reported: "No signs of activity in Aristarchus."

EARTH NOISE A radio astronomy satellite launched last July has detected strong bursts of radio waves coming from the earth. We may be making as much noise as Jupiter, probably for the same reason.

The bursts are in the low-frequency portion of the radio spectrum, less than 10 million cycles a second. They are not energetic enough to penetrate the earth's lower atmosphere, and so have not been detected from the surface. The radio satellite, 3,640 miles high, is picking up the signals from above.

Robert G. Stone, a NASA scientist in charge of the satellite, described the observations at a Washington meeting of the International Union of Radio Science. The radio bursts originate in an area between New Zealand and Antarctica where the lines of the earth's magnetic field curve down toward the surface. Auroral displays are seen almost every night.

A possible explanation has been offered by Kenneth Franklin, of the American Museum-Hayden Planetarium, a codiscoverer of radio bursts from Jupiter in 1955. He suggests that if the earth's magnetic field were to occasionally weaken, energetic particles normally trapped in the lines of the field would be freed to plunge into the earth's lower atmosphere at tremendous velocities. This explanation allows for the observed fact that the satellite does not detect the bursts each time it passes over the point of origin.

NO CHANGE ON VENUS How do you explore a planet whose atmosphere is so dense it crushes space capsules the way our oceans can crush submarines? Whose features may differ in height by 50,000 feet. Whose surface temperatures soar over 1,000 degrees.

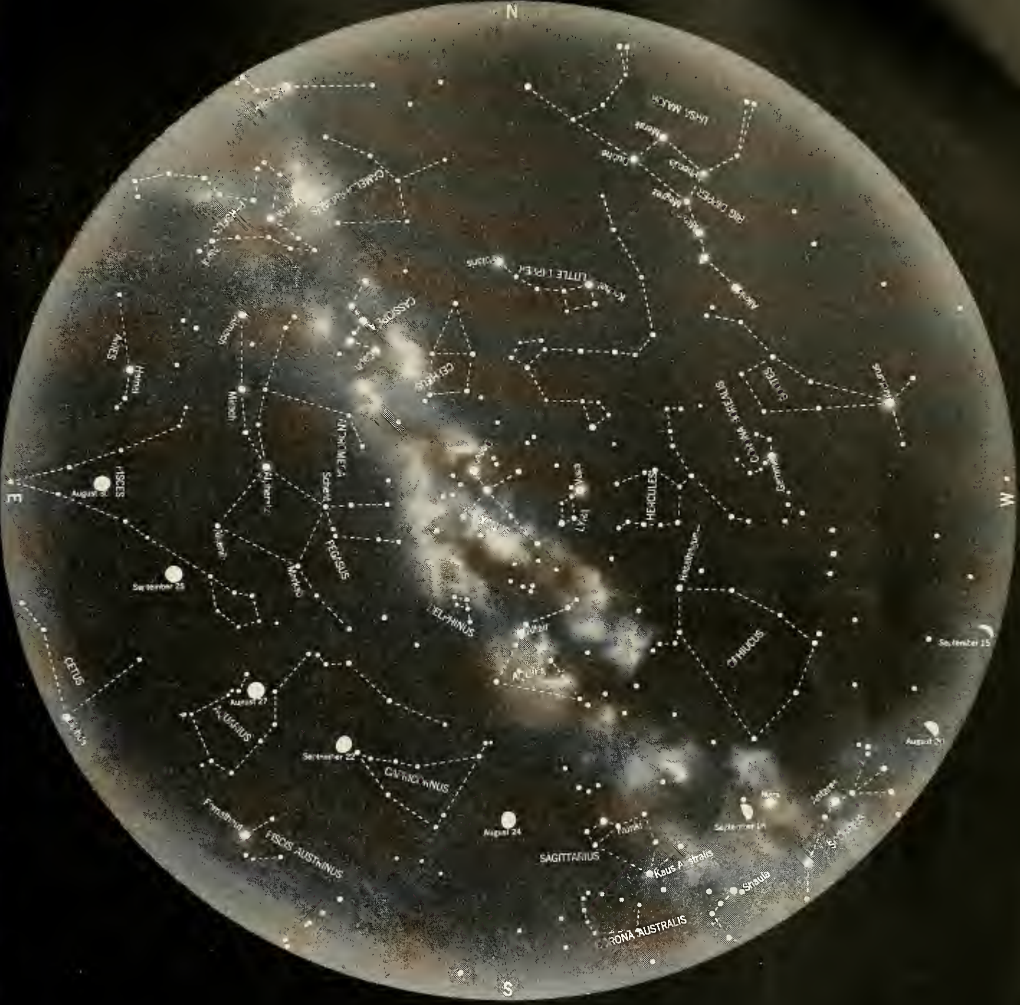
These are some of the questions raised by the fate of two Soviet capsules, Venera 5 and 6, which plunged into the Venusian atmosphere 24 hours apart last May. The Russians had confidently equipped them with Lenin's portrait and the Soviet coat of arms to be landed on the planet. Now it appears that both capsules were crushed by atmospheric pressure while still 12 miles above the planet's surface.

Both capsules hit the night side of the planet so their radio signals back to earth would not be lost in the solar radiation. They streaked into the atmosphere just 188 miles apart, but apparently found very different conditions.

According to Russian news sources, Venera 5 descended over a very deep basin. While its altimeter still registered more than 12 miles above the surface, Venera 5 reported the pressure was 140 times that on earth and the temperature was nearly 1,000 degrees. Venera 6, at the same altitude, recorded a pressure of 60 earth atmospheres and a temperature of 750 degrees. The Russians believe this capsule was coming down over a high plateau.

Extreme height variations on Venus would be a surprise. U.S. radar sweeps of the planet's equator indicate no differences greater than 7,000 feet. Theoretically surface temperatures are so hot, rock would act like plastic—a mountain would sink into the landscape.

JOHN P. WILEY, JR.


N
URSA MAJOR
Merak
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Megrez
Alioth
Mizar
BIG DIPPER
Alkaid
Polaris
LITTLE DIPPER
Kochab
CAMELOPARDALIS
CASSIOPEIA
CEPHEUS
ARIES
Hamal
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ANDROMEDA
PISCES
August 8
E
Alpheratz
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PEGASUS
Markab
September 25
DELPHINUS
Vega
LYRA
HERCULES
CORONA BOREALIS
Gemma
BOOTES
Arcturus
W
Rasalhague
OPHIUCHUS
September 15
Altair
AQUILA
CETUS
August 27
AQUARIUS
September 22
CAPRICORNUS
August 21
Antares
SCORPIUS
August 24
Fomalhaut
PISCIS AUSTRINUS
Nunki
SAGITTARIUS
September 18
Kaus Australis
Shaula
CORONA AUSTRALIS
S

CELESTIAL EVENTS

The moon in August is at last-quarter on the 4th, new on the 13th, first-quarter on the 20th, and full on the 27th. In September, last-quarter moon is on the 3rd, new moon on the 11th, first-quarter moon on the 18th, and full moon on the 25th.

Jupiter and Mars are in the evening sky. Jupiter is low in the west, but may not be seen after mid-September. Mars, in the south at dusk, near but brighter than the star Antares in Scorpius, sets around midnight. Venus will be a bright morning star, well up in the east at dawn. Saturn rises early in the evening and remains visible until dawn.

August 9: Venus is to the right of the rising crescent moon.

August 11: Mars passes near Antares for the third time this year, moving from right to left of the star.

August 12: The Perseid meteor shower, best of year, reaches maximum, with no moon to interfere with early morning observations. Observers may expect to see up to 50 meteors per hour, less for several mornings before and after the 12th.

August 16: Jupiter is close to the crescent moon.

September 18-19: Antares and Mars are to the left of the moon on the 18th, to the right on the 19th.

September 23: The sun arrives at the autumnal equinox, and autumn begins in the Northern Hemisphere.

September 25: The full moon tonight is the harvest moon.

September 27-28: Saturn is south of the moon and to the left (east) on the 27th, to the right (west) on the 28th.

September 29: Mercury is at inferior conjunction and enters the morning sky.

THOMAS D. NICHOLSON

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 11:20 P.M. on August 1; 9:20 P.M. on August 31; and 7:20 P.M. on September 30; but it may be used for about an hour before and after these times.

In 1545, Michelangelo cautioned a nephew about buying a house in the Santa Croce district, "every year there the cellars flood."

The Florence Floods

by Richard M. Klein

As it did to other presumably educated Americans, the announcement of the Florentine flood of November 4, 1966, aroused in me the immediate reaction of horror felt by most people when they hear of a natural catastrophe. Fragmentary stories on the wire services were followed by detailed descriptions of specific paintings damaged or destroyed, books soaked with water and oil, and accounts of death, hardship, and personal heroism. I shuddered at the evoked word picture of the odors of sewage, rotting animal and human flesh, mold and mud and oil. In the succeeding days, as is usual in our overcommunicated world, the stories receded into the back pages of the newspapers and fresh stories of other tragedies took over my attention.

Yet, there remained a nagging feeling that this flood should never have happened at the level of intensity and with such severe loss of the treasures of Renaissance Italy—indeed of Western civilization. As I read more about the history of the Florentine region, I began to realize that the 1966 flood was an almost classic example of how to ensure that floods will recur.

The area known as Tuscany is a well-marked and fairly compact geologic unit, which rises gradually from the western coast of Italy to the heights of the Apennine Mountains. It is a harsh land of hills and valleys, of winter rains and summer droughts. The valley of the Arno lies on the northern margin of the African trade winds and on the southern margin of the prevailing westerlies that bring rain from the Atlantic Ocean. In winter, the warm air above the sea forms a low-pressure cap that draws winds over the water. As these warm, moisture-laden winds flow up the hills to the Casentino mountain range, they cool, and the rain may fall furiously for several days in succession. Of the twenty-five to forty inches of rainfall that Tuscany receives annually, over 80 percent falls between October and January—much of this between late October through the middle of December. In the summer, there may be no rain for several months as the hot, rapidly moving winds from Algeria simply do not pick up enough moisture from the sea to supply rain.

Today, the hills surrounding Florence can scarcely support olives and grapes. There are occasional patches of scrub, including lavender, myrtle, rosemary, and thyme: aromatic, romantic, lovely to look at in flower, and completely useless as ground cover. The soil is leached-out clay with pockets of stone and sand. The sun beats down on impoverished and badly worn soil, changing it into a cementlike hardpan. In spite of, or perhaps because of, its aridity, the land above the city of Florence has a very real beauty. From the surrounding hills, one can take in the peaks of the Casentino mountain range, bared and gleaming in the summer sun. First in abrupt descents and then more gently, the highlands fall away to the foothills. Sere, brown, and rocky, the hillsides catch the early morning or late afternoon sun, leaving the hollows in deep shadow. From a distance, it seems a landscape devoid of plants.

The present city of Florenc stands on land that has been a par of the civilized world for more tha 3,000 years. Excavations have unearthed artifacts dating back to th Bronze Age, and there is some evidence that neolithic cultures flourished there even earlier. And wel they might have, for the Tusca valleys and hills were fertile an wooded, the climate then was generally mild, with just enough seasonal variation to stimulate, but no debilitate, the people, and there wa reasonable protection from marauders from the north. The major river the Arno, was a freshwater stream apparently abounding with fish, tha flowed throughout the year and wa broad enough to permit travel, an hence trade, with the coastal people through the delta that is now the cit of Pisa.

The earliest complex civilizatio about which we have reasonable information is that of the Etruscans Apparently they settled in what i now Tuscany about 800-600 B.C. coming from northwest Asia Mino via the Caucasus. In addition to being farming peoples, they were experienced merchants, and much o our knowledge of them is derive from their commercial activities The Etruscans found, settled, an exploited a land of some natura beauty. The Arno and its tributarie were clean, clear, fishable, and navigable. The hills were completel forested. In the valleys were foun the Aleppo pine and two evergree oaks, the Holm oak and the Valoni oak. These formed fairly open forests with understories of variou small trees and shrubs. The mid mountains contained excellent stand

These early stone buildings served as models for the Renaissance master builders, who made Florence a place of enduring beauty and, incidentally, laid out a city especially suited for flooding. As the city began to assume its present shape virtual bathtubs were created there – piazzas and squares with a single inlet. . . .

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of beech, Spanish chestnut, and deciduous oaks, and the upper mountains were clothed with black pine and several species of fir. There was an abundance of animal life, for figures on Etruscan pottery depict deer and bear hunts. In the fourth century B.C., Theophrastus mentioned the beech groves of Tuscany as being of such excellent quality that the wood was bought from the Etruscans for the construction of ships' keels. Some records suggest that they also sold fir lumber to Carthage. Even by 300 B.C. the forests in the hills were so dense that the Roman legions hesitated to invade. The plant cover was still notable several hundred years later when Strabo reported that the central Apennines and the hills of Etruria provided wood for the construction of Rome. The Sila hill range yielded "fine trees" and pitch for shipbuilding activities centered near Pisa at the mouth of the Arno.

The Etruscans were a vigorous people who attempted to use their land for many activities related to commerce. They planted olive trees and grapevines on the hillsides and farmed the valleys for wheat and barley. They mined some copper, zinc, and tin to make bronze for tools and weapons, and they probably also smelted mercury and some iron. Sheep were grazed on the lower hills to supply the white, black, and brown wools that were much prized for their softness, fineness, and natural colors. Thus, some deforestation and grazing injured the land, but the populations were too small to severely damage the fragile hills. By the end of the Etruscan hegemony, the Romans were lavish in their praise of this still-wooded, fertile, and well-watered land.

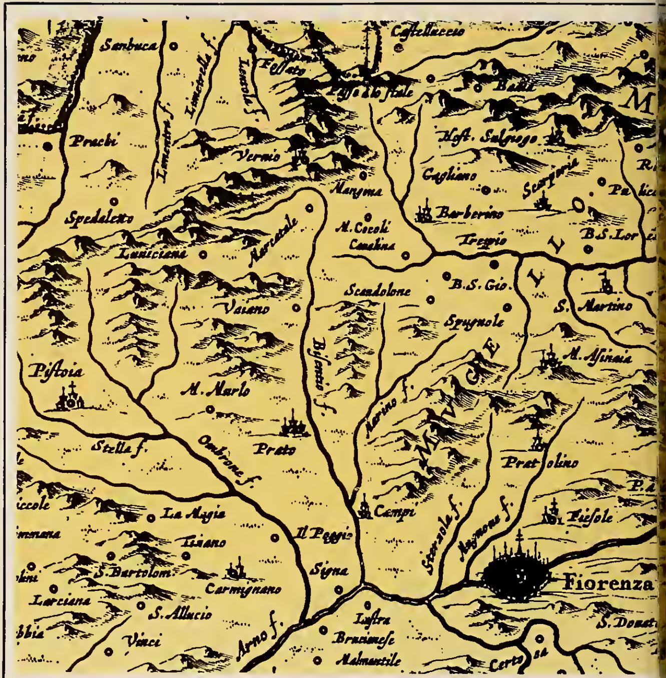
The first adequate records of floods date from the twelfth century, actually 1117, when the Ponte Vecchio, then the only bridge over the Arno, was swept away. These records show clearly that the Tuscan hills were denuded, the Arno was a seasonal stream, and the land was plagued by drought. If we date the demise of Roman rule at about A.D. 300, and we know that the land was ruined by 1117, we are left with approximately 800 years to account for in terms of physical geography. What happened to the forests, the clear streams, the good soil, and the fine climate? Can we use the meager records to fill in the details of man's rape of this land?

The primary city of the Etruscans was not the area of present-day Florence, but was the now small hill town of Fiesole. Present-day Florence was a lower suburb about 15 miles downstream on the Arno. The plain of the Arno is broken into a succession of old lake beds, which filled with debris and in which beds of travertine were deposited. Florence itself was initially situated where the Arno issued from the mountains at about 180 feet above sea level, a few miles upstream from its present location. The upriver location was determined by a simple fact—the site of the present city was a marsh. Indeed, when the winter snows melted in February, the river was not easily forded. Livy noted that in the late winter of 217 B.C., Hannibal and his armies floundered for four days in the muck of the valley floor. Yet, the river bottomland was very fertile, producing an excellent crop of hard wheat, some millet, and good barley. The snow melt served to supply nutrients, and the water moved out to sea by March, leaving enough time to plant. There was a second reason for the lowly political position of Florence, one related to the defense of the area. The Etruscan military wanted its citadel on the heights, not on the nearly indefensible valley floor.

Fiesole, as the political and defense center, tended to gather the greater share of the population, but it soon became apparent that this small, hilly area could not provide an adequate living for the populace. The hills about Fiesole had to be intensively cultivated and the only practical way to do this was by terracing. The technique was certainly not invented by the Etruscans; the Greeks and other peoples of Asia Minor had been cutting horizontal ridges into their hills for eons. In the Tuscan context, terracing was necessary more as a means of fully utilizing all land within the protected reach of the fort, than as a conservation measure (although it certainly served well in this respect). Cereal crops were not planted on the terraces, but were grown on the Arno Valley floor, and the crop was stored in the granaries of Fiesole. Vines were planted on the terraces, particularly on the drier, stony, south-facing slopes of the hills. Typically, the vines were festooned from tree to tree. Initially, the trees were native species, but these were replaced by the olive prior to the advent of the Roman invasions from the south. Thus, even before the rule of Rome, some of the plant cover on the hills had been removed. Since the Romans left no records of flooding, we can assume that the major portion of the Tuscan hills was still covered with plants that sopped up the water and prevented the destructive runoff that resulted in floods.

Tuscany, being on the route from the lands of the Franks and the Goths to that of the Romans, served as a staging ground for many armies. The mountains were no longer an effective barrier from the north as logistics and disciplined armies replaced wandering bands of military plunderers. Records are hazy and contradictory, but it seems that the Romans defeated the Etruscans several times between 300 and 200 B.C. and that about 200 or 150 B.C. Roman rule was firmly established. The Roman road system was extended through Tuscany, and during its construction the engineers tried to stay in the piedmont except where there was a necessary valley river crossing. The Via Julia Augusta crossed the Arno at the site of the present Ponte Vecchio to connect with the Via Cassia going to the north. Even then, the Roman legions knew it as a bad crossing because it was muddy and tended to flood in the spring. There are no records of massive winter floods, however.

Under the protection of the



Florence and Environs

legions and the Roman governor, Sulla, the population of Fiesole began to move down the Arno to where life was easier. When Sulla was defeated by invading Franks, Florence was leveled and burned, and again the people retreated to the hills. By 59 B.C., Florence was restored under the auspices of Julius Caesar to its present location and given the name Julia Augusta Florentina, the latter word apparently being a good omen rather than having any botanical allusions. The city was a typical Roman city-fort with temples, baths, aqueducts, and an efficient sewage disposal system. There was a central marketplace, now the Piazza Vittorio Emanuele, and the city was walled. Apparently there was some attempt to drain the swampy area then outside the city walls. Although flooding in winter did not assume sufficient importance to record, the Romans were well aware that snow melt was a danger, for they did erect levees on the banks of the now-contained, but still free-flowing, Arno.

The ancients knew the value of woodlands as flood protection. Plato deplored the reckless cutting of the Greek forests and pointed out the cause and effect relationship between forest destruction and the rapid runoff of rain from bared hills. Pliny quoted Plato when he admonished the Romans to maintain and to replenish their forests, and while we have no direct evidence, it seems likely that some form of forest conservation was practiced in the Tuscan hills.

With the population increasing, terracing also increased, but this stopped rather abruptly. Malaria, which had been introduced into Sicily from North Africa during the fourth century B.C., moved onto the continent during the Second Punic War of 218-204 B.C. By the beginning of the Christian Era, it reached Tuscany, where it became endemic in the lower valleys and in the city. Within less than a century, Florence and the hill towns had virtually been abandoned. The terraced farms, no longer cultivated, were subjected to erosion that washed away the precious soil. Lacking stability, it is easy to visualize the stripping of the soil from the hills, the mud slides, and the consequent silting of the tributary rivers and, eventually, of the Arno itself. Although no records exist, we are fairly safe in saying that minor flooding occurred in the Arno basin from about the middle of the first century A.D.

During the subsequent 300 years, the town of Florence continued to decline, local trade decreased, and the once relatively important Roman city became little more than a village. As the Roman Empire began to fall apart during the third and fourth centuries, tilling declined and the plowed land and terraced lower hillsides were subjected to direct erosion. The upper hills, however, began to restore themselves, and flooding probably decreased.

The fortunes of the city took a turn for the better by the end of the fourth century as the malaria began to disappear for reasons that are not known. The Lombards made Florence into a military center, and when the Franks replaced the Lombards in 774, the entire region assumed an increased role as a trade center. By then Fiesole had declined to the level of a town, a condition that has never been reversed.

As the population grew, there was a greater demand for wood to be used for construction and for fuel. The hills were rapidly stripped, so that by the end of the seventh century wood had become so scarce and expensive that stone became the primary construction material. From the perspective of the art historian, this had some importance. The artisans of the time were both good craftsmen and good architects. These early stone buildings served as models for the Renaissance master builders, who made Florence a place of enduring beauty and, incidentally, laid out a city especially suited for flooding. As the city began to assume its present shape virtual bathtubs were created there—piazzas and squares with a single inlet street and one or a few outlets. Water rushing into one of these squares could not easily pour out the other side

Marradi
Boco
Pian
Spefsia
S. Benedetto
Gabelli
S. Fior
C. dell'Alpi
Rondinaia
Godenzo
Radiconcoli
Dicomano
R. del Corniolo
Arno
S. Aldelle
Londa
Porciano
Stia
Ruffina
Caſentino
Pelago
Romena
B. alla collina
Strada
Tombrefa
Pop
Fron
C. S. Nicolo
Prato Magno
Rignano
Coccollo

tlas Novus, Mercator, 1638

and the whole area filled up. Most of the listed high-water marks of the 1966 and earlier floods occurred in these piazzas.

Although the Etruscans and the Romans engaged in the wool trade, and Florence had been a weaving center for many centuries, the increased use of wool cloth by peoples less exalted than the aristocracy resulted in a great increase in woolen mill activity. As the woodlands were decimated, the cleared land that resulted became pasture for goats and sheep. Now, both these animals nibble forage to the root level, effectively killing the individual plant. The overgrazing became so severe that by the eighth century the Florentine mills could no longer depend on local wool and hair, but were forced to import it from England and Spain. Parenthetically, it is likely that the denuded Spanish hills are partially the result of overgrazing by sheep to supply wool to Florence.

The effect of land clearing on the climate of Florence is not easy to document. Modern ecological and ecophysical studies show that forested areas serve as natural air conditioners. Heat is collected by trees during the day and released slowly at night. Modified by the cooling power of evaporation, the heat never builds up as it does when captured by stone and paving; a walk from a city street into a park at dusk illustrates this dramatically. The presence of nothing but baked clay on the hills above Florence served to perpetuate its summer heat and drought. The forests served, as the Etruscans and Romans knew, to ameliorate the heat of the summer. Not incidently, the absence of the forests with their water-holding capacity resulted in loss of scarce summer moisture and the rivers and brooks ceased flowing in the summer.

By the beginning of the ninth century Florence had about 30,000 people, and the old walls had been breached and built farther out several times. The region had many different rulers, none particularly firm or effective. The weak rulers gradually let power slip from their hands, and authority, power, and ownership of the land became divided among the Roman Catholic bishops and a few wealthy landowners. These interlocked concentrations of land ownership led steadily toward the development of a feudal system in which relatively large areas were tilled by serfs for the production of a few economically important crops and products. Goats and sheep continued to graze, and meadowlands were cut from the forests farther up the hills. With the removal of the sparse grass, the summer droughts baked and caked the clay soil to the consistency of rock, and natural seeding in it became virtually impossible. Bound to squeeze the last florin of profit from the country, the church and the landowners made no attempt to replenish their land. Tuscany, a land noted for good water, forests, and fine agricultural bottomland inexorably declined into the arid, bare, and impoverished country that we see today. The greed of the church, the avarice of the aristocracy, and the ignorance of the people have given us this legacy.

The remainder of this sad tale can be told rather quickly. The first complete record of a major flood was provided by Giovanni Villani for the flood of November, 1333. There was an average of four feet of water, the city walls collapsed (never to be rebuilt), and three of the then four bridges over the Arno were destroyed; the Ponte Vecchio stood firm. Quoting Villani: "Wherefore everyone was filled with great fear and all the church bells throughout the City were rung continuously as an invocation to heaven that the water rise no farther. And in the houses, they beat the kettles and brass basins raising loud cries to God of '*misericordia, misericordia*,' the while those in peril fled from roof to roof and house to house on improvised bridges. And so great was the human din and tumult that it almost drowned out the crash of the thunder." Not unexpectedly, the flooding was worse in the low-lying districts nearest the Arno. Three hundred people died in the hard-hit districts of San Piero Scheraggio and the Porta San Piero. On the Via de Neri the flood crest was 13 feet, 10 inches, only 14 inches lower than during the 1966 flood. Villani carefully listed the losses of grain and casks of wine, and in quite modern fashion he noted the cost of bridge repair, as well as municipal outlays for cleaning the streets and for minor compensations to citizens.

Villani noted the extraordinary rainfall over the Arno watershed, but then wrote, "On May 15 there was an eclipse of the moon in the sign of Taurus . . . and then at the beginning of July there followed a conjunction of Saturn with Mars at the end of the sign of the Virgin." The church had the last word, stating that "by means of the laws of nature, God pronounced judgment on us for our outrageous sins." There was slight consolation from the King of Naples, who told the Florentines that "whom God loveth, He chasteneth." The Florentine Renaissance has opened with a bang.

A tiny note of biological intelligence was, however, struck by Gianbattista Vico del Cilento, who recommended a government-sponsored reforestation plan. Two hundred years later—the plan never having gotten off the ground—Guistino Fortunato dismissed Vico's plan. stating that trees were ugly and useless.

We need not detail the economic and biotic history of Florence beyond 1333. In spite of accurate information on causes of floods and adequate technical information on flood control, nothing was done. Vico was probably not the first, and he certainly wasn't the last, to chastise the Florentines for their laxity. Giovanni Batista Adriana said that the severe flood of 1547 badly disturbed the people who demanded that something be done. They were told that God wanted, with this act, to signify that worse calamities would occur, so they decided to wait. In 1545. Michelangelo cautioned a nephew about buying a house in the Santa Croce district, "every year there the cellars flood." His warning was apt, for the flood of 1547 was followed by another in mid-September of 1557, when the entire Santa Croce district was under several feet of water. Lorenzo di Medici warned the population about the Arno: "Its arrogant anger splits and beats away at the weak banks." But in spite of his authority to order new construction, he did nothing. and there is no evidence that the people heeded the warning.

Leonardo reported that the streams of Tuscany were muddier when they passed through populated districts and suggested that the mud was washed-out soil that clogged the streams and leached the soil of the hills. He conducted surveys and designed projects to develop water impoundments in the hills, to dredge the tributaries of the Arno and the Sieve, and to develop chambers under the city to hold excess floodwaters. These, too, were ignored.

The Tuscan flood situation had only one useful effect. In 1861, President Lincoln appointed the Vermonter George Perkins Marsh as first American minister to the kingdom of Italy. Marsh's travels in Tuscany and his reports on the relatively minor floods of 1861 and 1863 undoubtedly contributed to his thinking in the preparation of *Man and Nature or Physical Geography as Modified by Human Action*, published in 1864. As a result of the interest (indeed the controversy) created by this book, Marsh was asked to help compile the irrigation laws of Italy, laws never adequately enforced, which could have alleviated the floods that have occurred during the past 75 years. It must be noted that Marsh's book so stimulated Gifford Pinchot that he persuaded President Theodore Roosevelt to set into motion the legislation leading to the conservation policies of the United States.

For what it is worth, the statistical picture is gloomy. Since 1333, there has been a moderate flood in Florence every 24 years, a major flood every 26 years, and a massive flood every 100 years. Of the massive floods, those of November, 1333: November, 1844; and November, 1966, have been the worst. Since 1500 there have been more than 50 floods qualifying as moderate and 54 qualifying as major.

In 1797, a French engineer, Fabre, announced that the alpine torrents that flooded the lowlands were a direct result of deforestation of the heights. One hundred years later, in 1890, the French government undertook the job of reforestation in the Hautes-Alpes. Engineer Surell reported that as reforestation continued, floods decreased in number and severity. This report was widely distributed in Europe, was acted upon in Germany and Switzerland, but was ignored in Italy.

Apparently no one in Florence could believe that water could cover their city in the twentieth century. But they, themselves, place marble markers on their homes and churches "commemorating" previous floods. They, themselves, proudly indicate the high-water marks of floods dating back 500 years. They, themselves, speak of their dry, bare hills, which shimmer in the summer sun. and they cannot fail to see that their "ribbon of shining silver," their Arno, is a muddy, silted-in, malodorous stream that almost stops flowing during the summer.

The New York Times of January 2, 1969, reported that during the week preceding Christmas of 1968—two years after the most damaging
flood in Florentine history—the Ar
crested toward the flood mar
"Only after the river began to su
side at 9:00 P.M. did the crow
move homeward." The bed of th
Arno is still filled with the debr
of the 1966 flood and has never bee
dredged. It is now estimated th
the silt from 1966 alone is six fe
thick.

There are two dams on the Arn
the Levane dam at Livorno, 35 mile
upstream from the city, and th
Penna dam, yet higher into the hill
These are power dams and do n
provide for flood control. No mone
has been (or apparently ever was
appropriated for reforestation a
recommended in 1334 by Vico. f
the construction of water impoun
ments and for dredging the Arno a
recommended by Leonardo, or f
caring for the land as recommende
by Plato.

It is beyond the scope of th
article to discuss the storage of i
replaceable books and art treasure
in the basements of Santa Croc
noted by Michelangelo as the di
trict where the cellars flood ever
year. It is beyond the scope of th
article to discuss the reasons for th
lack of coordination between th
two dam sites. It is beyond the scop
of this article to discuss the lack c
retaining walls bordering the Arno
even Lorenzo did nothing abo
them. As George Santayana warne
in his *Reason in Common Sens*
"when experience is not retained . .
infancy is perpetual. Those wh
cannot remember the past are co
demned to repeat it."

Since 1333, there
been a moderate fl
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Rarest Booby

Isolated from the twentieth century, a small but viable population of Abbott's Boobies decorates Christmas Island

Like Wordsworth's cuckoo, Abbott's Booby (*Sula abbotti*) is a disembodied voice, a vast, booming shout rising from the jungle's obscuring canopy. This magnificent seabird, which bears the name of a distinguished American patron of science, is among the rarest in the world, found only in the jungle recesses of remote Christmas Island in the Indian Ocean.

As your phosphate cargo boat bucks through the breezy waters surrounding Christmas Island, 700 miles northwest of the nearest bit of Australia and 260 miles south and slightly east of Java Head, you will meet Brown and Red-footed Boobies, *Sula leucogaster* and *S. sula* (we saw fishing Red-foots 300 miles from the nearest land), but you will be lucky if you spot the lean Abbott's Booby, its head projecting far forward as its long, narrow wings stroke in easy, shallow rhythm. Its rakish shape and square tail are enough to set it apart, but the white back between black wings; the snowy head, neck, and underparts; the black tail; and the black-and-white spotted rump above black thigh patches are diagnostic. The pink bill identifies an adult female, but a blue-gray one indicates an adult male or juvenile, the latter two being virtually identical. This is why, until our visit in 1967, no ornithologist had ever knowingly set eyes on a juvenile Abbott's Booby; they had looked for a drab juvenile plumage, distinct from the adults', as in all other gannets and boobies.

You need luck to spot one, because there are so few Abbott's and so much sea, and because they have special fishing grounds that you are unlikely to traverse. But the aura of mystery that has always surrounded this bird depends, not on its elusiveness at sea, but on its inaccessibility in its nesting haunts. All other boobies form noisy colonies on islands, some species spanning the tropical belt of the globe; all nest on the ground except for the Red-foot and even that bird often nests low in bushes or small trees. But Abbott's chooses the tops of tall jungle trees, often 100 feet high and usually above the 500-foot contour. Perhaps no large seabird has remained so obscure, despite the efforts of ornithologists. Until now, unphotographed and virtually unknown, Abbott's Booby has always conducted its ecstatic courtship, built its nest, laid eggs, and reared its young in such inaccessible habitat that Arthur Pearson, the last naturalist resident

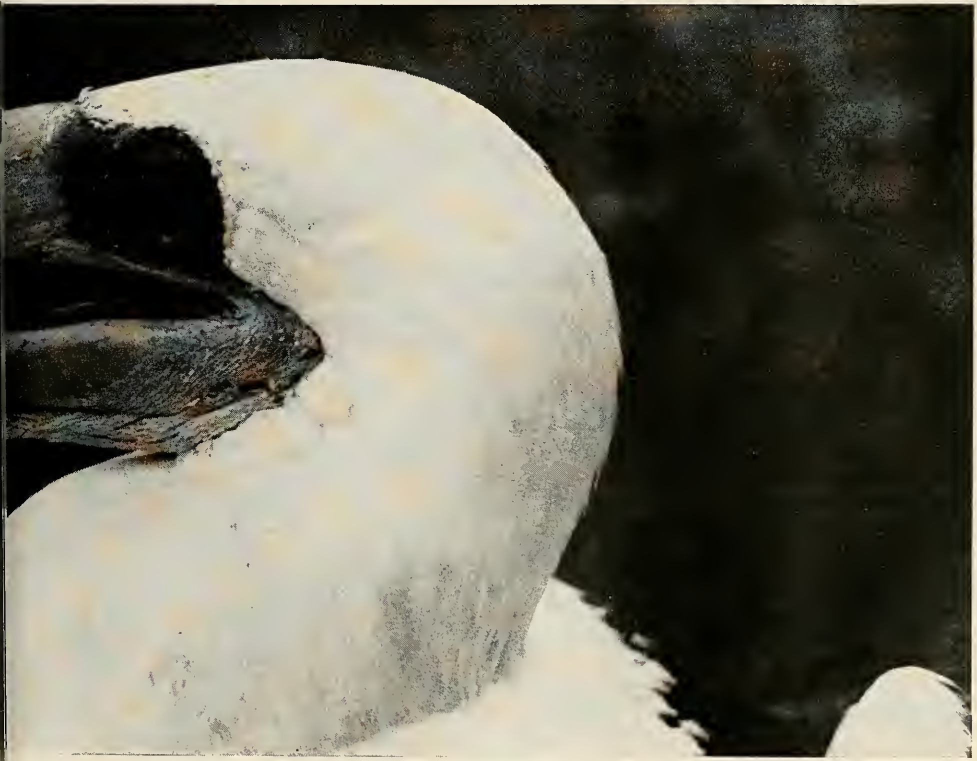
by Bryan Nelson

t Christmas Island, saw only three ests in four and a half years and stimated the total population at erhaps fewer than 100 pairs. A few ecades ago, Gibson-Hill, well known or his work at the Singapore Raffles useum, spent two years on the isand, and his guess of 500 to 700 airs has been the most widely acepted figure.

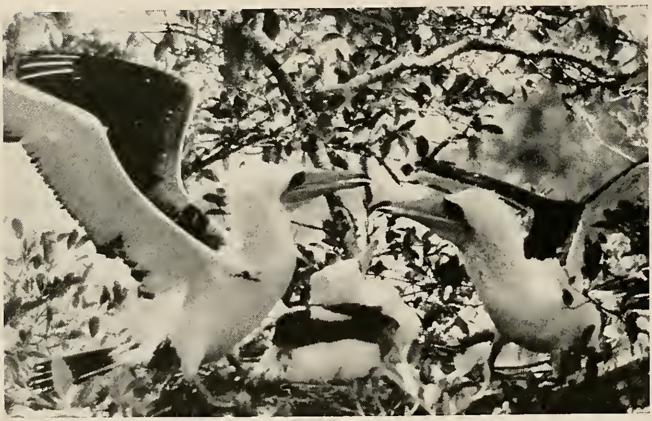
So we wrote on a clean slate when e began our investigations of Abott's Booby. On the afternoon of arch 28, we stood in a clearing mong massive trees, and truly it eemed a strange spot for seabirds. thought of the Red-footed Boobies n the Galápagos, nesting by the undreds in shrubs three feet high. ut here, below a sky still gray with onsoon clouds, in thick, wet vegeation under a dense screen of trees, hat chance was there of seeing an Abbott's Booby, let alone doing careful work on the species? One was sighted, but it was at a great distance—an albatross-like bird circling high over the island on long wings. We were disappointed. Our arrival, hopefully planned to coincide with the beginning of the nesting season, seemed to have been mistimed. After an intensive search we found only a few fully grown juveniles still being fed by their parents—no nests, eggs, or fledglings.

Pairs feeding juveniles in April or May cannot possibly lay eggs in those months, so it seemed that the breeding season was ending, not beginning, and that these pairs with juveniles would not begin another breeding season until at least some months later. If, however, the season for egg laying really was restricted to April and May each year, as earlier ornithologists had reported, we reasoned that some pairs must have been preparing to breed while others were finishing, and the latter would have to wait until the *following* April-May, thus breeding only once in two years. We did, in fact, eventually find good evidence that each pair of Abbott's Boobies does lay sometime between late April and July in alternate years. We found eggs only in that period. In those months the entire breeding population of Abbott's consisted either of (1) pairs with, or preparing for, eggs, or (2) pairs feeding free-flying young. No birds, then, had laid between about October and March, otherwise we would have seen partly grown young on our spring visit.

But these discoveries lay ahead. Our first reaction was chagrin at having arrived at what seemed to be



Alternating in their nest tending, adult Abbott's display wing-waving behavior upon reunion.



the wrong end of the breeding season. A lucky find restored our optimism, however. High in the branches of a cliff-hanging banyan tree we spotted a dark, nestlike mass. Even better, we found we could scale the cliff, and after a short but tortuous scramble among jagged limestone pinnacles covered with ferns and thorns, we arrived at the foot of the tree. To our knowledge nobody had ever reached an Abbott's Booby nest; at best, they had peered at one through seventy feet of foliage. Here we had a fine chance of getting right up to one. This small cliff lay on the 700-foot contour in the northeast quarter of the island. Abbott's Boobies liked the area because the trees near the top of the cliff projected from the forest level and were therefore easy for takeoff and landing.

We located about ten local nests and succeeded in making detailed observations of five of them. The results of this study form the basis of this account, the first ever to be published on the breeding biology of this bird.

Abbott's Booby is listed by the International Union for the Conservation of Nature among the world's endangered species, a judgment based on the best available evidence before our study, which indicated a population—reported to be decreasing rapidly—of 100 to 700 pairs. It is pleasant to report that the breeding population is in fact not less than 2,000 pairs and may be more. During our stay on Christmas Island, we actually located 725 pairs, but due to the roughness of the terrain and the consequent difficulty of locating nests, this figure probably represents less than a third of the island's total. There seems to be little doubt that Abbott's Boobies are more plentiful than previously thought. The population, though small, is vigorous and successful, and there is absolutely no reason why, if conditions stay as they are, the species should not always remain viable at its present level. It is not a fading and failing population.

Unfortunately, however, the situation will change. Australia is rapidly expanding its exploitation of Christmas Island phosphate for fertilizers. It seems possible that up to 70 percent of the island's vegetation will be destroyed within a relatively few years. Much of the boobies' best habitat is scheduled for clearance. The British Phosphate Commissioners, in recognition of their responsibility for Christmas Island's possession of one of the world's outstandingly rare and interesting seabirds, are currently considering its plight, but may be unwilling to sacrifice any phosphate on its behalf. In that case, the only hope is that enough uncleared areas acceptabl to Abbott's will remain.

In order to investigate the distribution of Abbott's on Christma Island, we constructed a map of nes locations. Once we had accumulate enough dots (nests) on the map, i was clear that although they seeme to be solitary nesters, randomly distributed over the inland plateau Abbott's Boobies do actually tend t nest in groups, sometimes markedl so, although many nests are far fro the nearest neighbors. While Abbott's takes its place as the least colonial of all boobies, it still show traces of the colonial tendency.

The groups correlate their nestin sites with certain features of the environment. At first we thought tha tree species or size was decisive, bu this is true only up to a point. Whil this booby chooses relatively tall an emergent trees and neglects spars and more uniform stands that occu on stonier and less fertile ground there are large areas, particularly o the east of the inland plateau tha are bare of Abbott's and yet posses lovely trees. What do they lack?

Eventually our map showed tha the nests were clustering around th sides of small ridges and valley and an investigation of areas wit these features produced Abbott' nests in notably greater number than elsewhere. It seems that thes

irregularities in the ground, and therefore in the jungle surface, facilitate landing and takeoff. It is even possible that they form valuable visual "fixes" for incoming birds, particularly the inexperienced juveniles newly on the wing. It must require pattern-perception of the highest order to pick out a tree from a vast expanse of uniform jungle top, and the landmarks provided by conspicuous irregularities are probably a great help.

Six to eight weeks before laying, the adult birds begin to display. Since the departure of their young they had occasionally returned to the nest tree, but they showed little interest in each other or in the site. Their nests, substantial though they were, may have disintegrated months ago in the monsoon rains.

As the breeding season advances, however, they begin to come to the home tree earlier, leave later, and are more alert on their conspicuous vantage points. Males, in particular, circle their home area, peering down nto the tree each time they sail past or flying off to a nearby treetop to wrench off long sprays with which they begin their nests. The first sprays must be long enough to drape over a broad bough or lodge in a wide fork. When the pair meet, the forest echoes to their sonorous clamor. During their ecstatic meeting, the mates usually perch on separate branches several feet apart, rhythmically beat their great wings, raise and lower their whole foreparts with head and neck outstretched, and shout in a deep, unbirdlike voice, so much more musical and dignified than the raucous cries of most seabirds. Early in the season a meeting ceremony may last for two minutes, periodically scaling new heights of ecstasy. Then, carefully moving sideways on the bough, the male approaches the female, his large, gray, black-tipped webs and sharp claws securing a firm grip on the bark. He launches himself in great leaps down from bough to bough, toward the female, landing flat on his feet with a terrific thump. After the greeting ceremony, copulation may occur, both partners conspicuously ruffling their long head feathers, which stand out spikily and greatly enlarge the apparent size of their heads.

After copulation, which is performed on the stable platform of the nest, the male usually leaves to gather more nest material. As he moves away from the female both begin to snap their heads violently up and down and sideways in an oddly spasmodic way, sometimes jerking themselves into the air with the vigor of the movement. Occasionally they lean toward, or jab at, each other, although always from too far away to reach. This is an aggressive display and its occurrence in the pair context is not surprising, since all boobies show aggression to their mates, sometimes violent (as in the gannet). Aggression is always more likely to flare up as one partner is leaving its mate. It is more or less inhibited, perhaps mainly by sex motivation, when the pair are together on the nest, but is released by decreasing contact as one of the birds moves away.

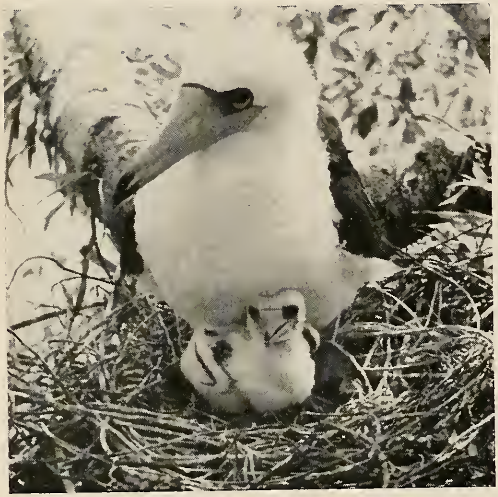
Abbott's Booby has two obvious aggressive displays—its meeting ceremony or wing waving, and its head jerking—and both are used between mates as well as against rivals. For example, a male will drive away an intruder by wing waving or head jerking and he will also greet his mate by wing waving, with, under certain circumstances, some head jerking. Other birds, gannets for instance, have special aggressive displays reserved solely for rivals, and special appeasement behavior used between partners. Also a pair of Abbott's never engage in fighting. Perhaps, in the case of Abbott's limited aggressive activity, the dangers of the treetop setting are so great that natural selection has banned all activities that increase the likelihood of a fall, provided that these can be replaced by less dangerous displays.

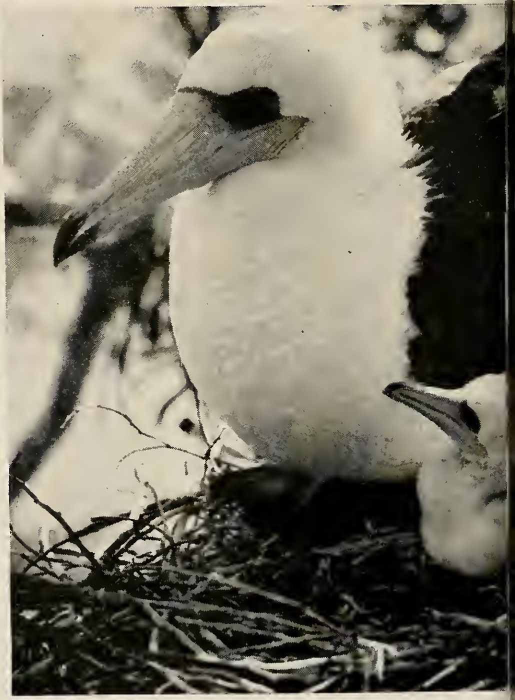
The Abbott's bulky nest is usually placed in a fork, which may be horizontal, vertical, two-stemmed, or multiple, although it sometimes rests precariously among slender terminal twigs. Horizontal forks seem to be preferred, perhaps because the birds can then sidle cautiously along until the branch diverges instead of having to negotiate a vertical hop. The single, large egg weighs considerably more, both absolutely and as a percentage of the female's weight, than that of any other species of the sulid family. Partly due to its great size, it takes exceptionally long to hatch—56 days. Incubation is shared, and the length of duty for each adult ranges from one to five days between reliefs.

The chick is at once unmistakably an Abbott's—large-headed, gray, and solid. At first, adults feed the fledgling in a way shown by no other sulid. Food is regurgitated into the bottom of the nest and is then attacked with inexpert zeal by the wobbly, uncoordinated baby. A parent will also feed its young in the typical sulid way, proffering its open mouth into which the chick inserts its head. This soon becomes the only method.

The young booby soon takes on the appearance of its parent, and adult and tiny young, side by side, look comically alike. It grows far more slowly than any other booby, and is guarded unremittingly for the first 35 days, after which it is left to itself more and more. Unlike other boobies it never indulges in playful attacks on its parents, and food begging proceeds only with marked restraint. All other boobies beg frenziedly. Both these points may again relate to the dangers of its treetop home and the need to guard against a fall.

Six months elapse before the youngster is ready to fledge, by which time it closely resembles an adult male, except that its wing coverts may contain a few brownish feathers. Its life then consists of long, weary waits in the green light of the treetops, punctuated by the increasingly infrequent arrival of a parent and the subsequent feed. Eventually adults become less anxious to surrender their fish, and the juvenile must beg, literally by the hour. Its distinctive, repetitive notes regularly interspersed with grating, drawn-out growls become one of the common jungle sounds in the hot





The developing Abbott's Booby quickly takes on the appearance of its parents. Chick at right is about two months old.

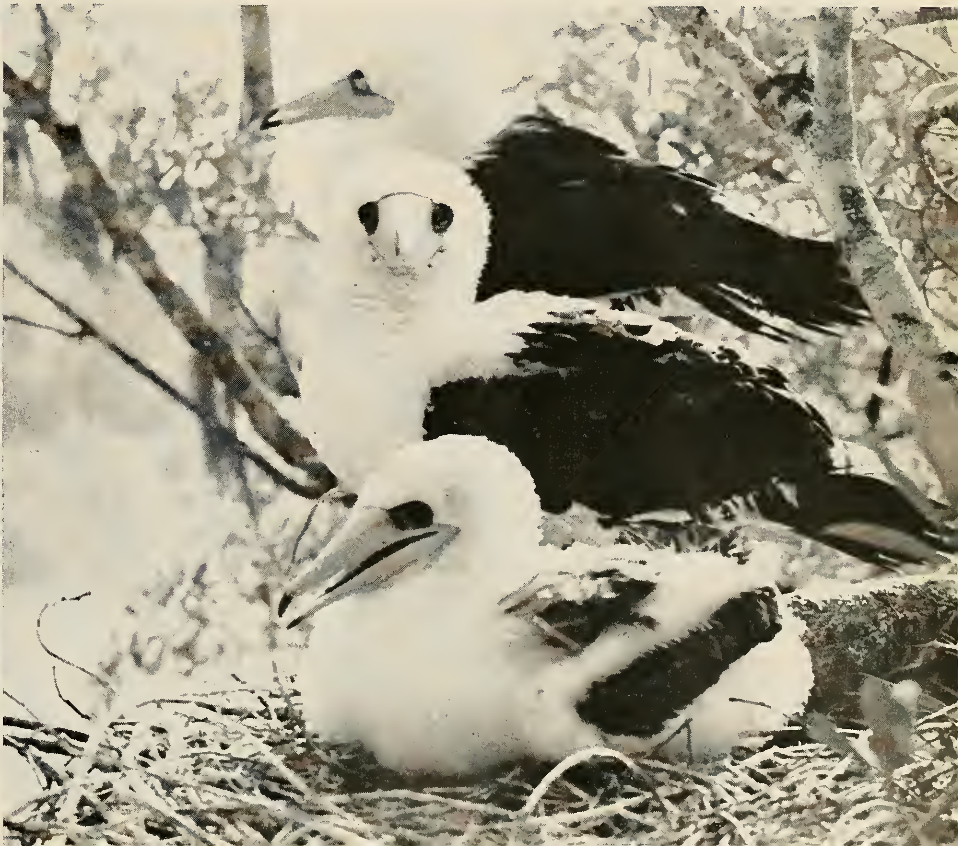
afternoons. But even when desperately hungry, its movements are restrained, and it never touches its phlegmatic parent, whereas juvenile Red-footed, Blue-footed, or White Boobies almost decapitate their harassed, food-bearing parents.

After several months of this post-fledging dependence, free-flying but not yet capable of fending entirely for itself, the juvenile Abbott's at last becomes proficient and disappears. Its parents have become impossibly stubborn and the juvenile takes to the sea, as do other boobies at a comparable time. Nobody knows where, in the vast Indian Ocean, they go or how long they stay before returning to breed, but it is certain that they return to Christmas Island and in all probability to the vicinity of their natal tree. All our observation pairs were, at one time or another, visited by a third bird, which surprisingly, was tolerated and may well have been the offspring of the previous nesting. The entire nesting operation has taken more than a year: two months for nest building and pair bonding, 56 days for incubation, about six months for the chick to begin flying and three or more further months of dependence on its parents. Add to this a period for rest and recuperation and we see why Abbott's Booby can nest only biennially. The apparent restriction of egg laying to the period from April to July clinches this.

How then does the enigmatic Abbott's emerge from this study? Esthetically it is a lovely bird, singularly remote and dignified. Other boobies seem busy and quarrelsome, even petty, beside Abbott's. Its large, dark eyes lend a benign expression, and its extreme tameness at close quarters—perhaps because interference has arisen too infrequently to encourage fear—is an engaging trait compared with the screeching aggression of its molested cousins.

Christmas Island is unique. Here, and here alone in the world, Abbott's Boobies still drift in from fishing, still descend from immense heights into the green sea of jungle and raise echoes with their wonderful voices as the reunited pairs display ecstatically. It would be another sad story if this splendid bird had to go, finally overtaken by the exterminating twentieth century.

Unlike many another rare animal, it has not yet been reduced to a remnant. At this moment it survives, along with its environment, virtually untouched. There is a fair chance that intelligent conservation can preserve it as a reasonably healthy population, but on the other hand, reckless clearing of the Christmas Island jungle in the search for phosphate will probably spell extinction for *Sula abbotti*, and the margin is narrow. The threshold of viability can not be far away when the total population is already so small.



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films, it became a fad sport for teenagers, and beaches from Malibu to Sydney were invaded by thousands of young, rambunctious surfers and surf-followers.

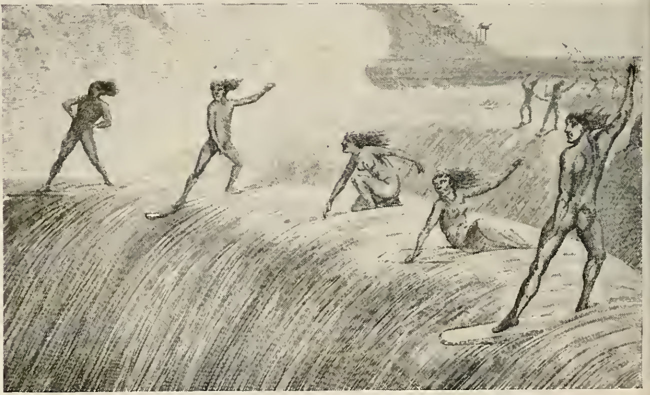
In the late 1950's, as the rising demand for boards made balsa more and more scarce, builders began fashioning boards from ultralight, solidified plastic foam, called polyurethane. Easy to obtain and easy to mold, this material brought mass production to surfing. New, larger firms entered the field. National advertising and installment and mail-order buying became regular features of a business once dominated by a few garage shops where boards were handcrafted for each customer. The resultant flood of foam boards were eagerly bought by veteran and novice surfers alike.

In the early 1960's these easily exportable foam boards, and the surfing techniques developed by a new generation of surfers, spread from California and Hawaii to overseas surfing centers, and then to areas where surfing had previously been unknown. Within a few years the coast of France around Biarritz had become a major new surfing area, together with hundreds of other spots scattered along both coasts of North and South America, Europe's Atlantic and Mediterranean shores, parts of Africa's coastlines, and new island surfing meccas like Maritius and Puerto Rico. Even frigid waters have not completely limited surfing's spread to temperate latitudes. With the assistance of neoprene diving shirts and suits, surfers ride waves year-round off the coasts of Japan, Oregon and Washington, and the British Isles.

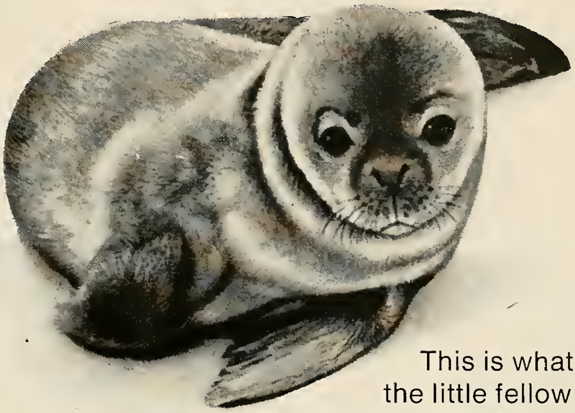
The sport has not stopped growing. New surfing areas are discovered every season. Builders continue to experiment with board shapes and surfers with riding techniques. Yet for all its expansion surfing remains inseparably linked to the islands where it first thrived. Hawaiian surfers themselves still hold an important place in their ancestral sport, and many have international standing. The Kahanamokus and Freeths of sixty years ago have their modern counterparts in such skilled instructors as Rabbit Kekai, and in overseas experts like David Nuuhiwa, who makes his home in California where he is a reigning champion.

Geographically, no one has yet found a coastline to match Hawaii's blend of balmy climate, comfortable water, exotic beauty, and year-round selection of favorable waves. Surfers everywhere look to Hawaii and save their money to travel there, arriving each year by the thousands—from places like Los Angeles, Melbourne, Lima. Some try the gentlest rollers at Waikiki, others test themselves against the raging winter storm surf on Oahu's north shore—awesome twenty-five footers that present the ultimate challenge in wave riding.

With its deep ties to the island's early culture, surfing was one of the few elements of Hawaiian life to survive into modern times. From Hawaii the sport has spread, in this century, around the globe. Today Hawaii continues to be not only the historical source but the vital center of an international surfing world. ☐



Can you be indifferent?



This is what
the little fellow
looked like before it
was skinned alive.

The seal shown at the right below is crying out to the man because he has just skinned her little one alive.

The pup was skinned before its mother's eyes because that was the quickest way to get a perfect seal skin. Hundreds of thousands of baby seals are butchered this way every year.

Help the Cry to Be Heard

Please help *Friends of Animals,* a non-profit organization, carry the animal's cry to that small minority of human beings who cannot be indifferent to suffering, even of those apart from their own family and species.

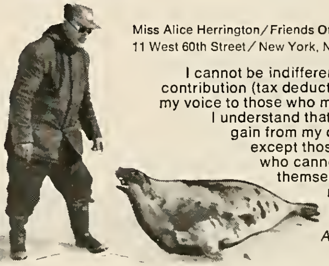
Protest Against This Indifference, Too

Millions of puppies and kittens are allowed to be born every year only to be abandoned by their owners. Most of this cruelty is preventable. A simple spaying operation can prevent breeding. Even though the world cannot support all the puppies and kittens its pets will produce, it can prevent their coming into the world in the first place. That much could be done.

What Friends of Animals Does

By propaganda in media and through the mail, by personal appeal, by subsidies to animal hospitals and veterinarians, *Friends of Animals* tries to the full extent of its resources to reduce the total of unnecessary suffering inflicted upon animals.

If you are one of the small number of human beings who cannot be indifferent, please make your protest felt by helping *Friends of Animals* reach the world's conscience until some response is forthcoming.



Miss Alice Herrington/Friends Of Animals, Inc.
11 West 60th Street/New York, N.Y. 10023

I cannot be indifferent. Here is a contribution (tax deductible) to add my voice to those who must protest. I understand that no one will gain from my contribution except those creatures who cannot speak for themselves. Please make check payable to *Friends of Animals, Inc.*

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Trailing Lewis and Clark

Continued from page 13

took a short side trip to Theodore Roosevelt National Park to experience some of the rough terrain that had to be explored in determining the original route. We saw mule deer, took good pictures, and from a high overlook studied the magnificent scenery. On the bare sides of the hills different minerals may be seen. There are black layers of coal and reddish layers where the coal has turned color from fires that once burned inside. This burned layer is called scoria and is a delicate pink in color. Lewis described the same area: "The bluff is now on fire and throws out considerable quantities of smoke which has a strong sulphurous smell." The natural vegetation here is mostly sagebrush on the much eroded hills, with juniper and red cedar mixed with the cottonwoods along the river.

About 45 miles west of Riverdale, North Dakota, where the Little Missouri empties into the Missouri, the land is level and fertile. Huge herds of buffalo roamed these prairies, and as the masses moved to the water to drink many were drowned. Their carcasses were fed upon by bears and wolves, which were present in large numbers. The bald eagle was abundant then along the river, and we were able to get many pictures of them, as well as of sparrow hawks, ospreys, and geese, or "brant," as Clark called them. The bears have retreated, though, and the wolves are gone from this state.

We were filled with anticipation at this point because there were no large cities for 168 miles ahead of us, and we would be experiencing the isolation we had hoped for.

Between Culbertson and Wolf Point, Montana, we had an experience reminiscent of Lewis and Clark's sighting of buffalo bogged in the water. We came upon two sheep that had fallen over a cliff and were stranded at the water's edge. We used a rope to haul the sheep back to safety, but proceeding upstream, encountered ten more completely stuck in the mud. Five were already dead, but after two hours of work, we dug the live sheep out and hauled them up the bank where they sank to the ground unable to move. On this stretch of river you rarely see a house—deserted or otherwise—but you constantly see domestic animals, primarily cattle and sheep. The ranchers live far from the river and probably don't have an exact idea of the number of animals they have or where they are located. The animals tear the banks down as they come to drink and cool off. When a bank collapses, as it did in this case, some will die and add their remains to the river pollution. Most of the herds are sprayed with insecticides, which work their way into the river and either kill or lower the reproductive rate of many of the organisms living in the river. By going along the entire water route you come to realize that the number of animals involved is considerable and that they add a great deal to river pollution.

On July 16 we left Fort Peck on the third leg of our trip and headed for James Kipp State Park, which is the beginning of the Wilderness Waterway, a 180-mile length of river, which is being considered as an addition to the country's "Wild Rivers" system. This was the portion eagerly anticipated by the men in our crew, for they expected it would be both wild and beautiful. The most scenic section of this part of the river is referred to as the "White Rocks," huge outcroppings of limestone so distinctive that Lewis and Clark named many of them: Castle Rock, Cathedral Rock, Dark Butte. In 1833 an artist by the name of Bodmer traversed this area and made magnificent sketches, and we carried copies of both the Lewis and Clark journals and of Bodmer's drawings. The rocks have

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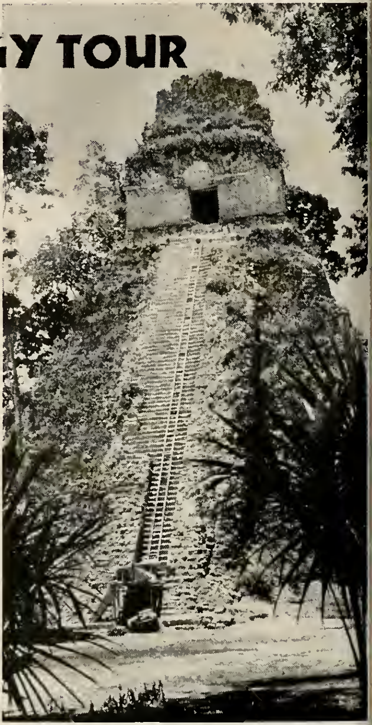

eroded very little, and we could identify many of the formations, which in the mind of Captain Lewis evoked images of ". . . eligant ranges of lofty freestone buildings having their parapets well stocked with statuary."

Inside the Wilderness Waterway, for the first time on our trip, the water cleared and the river was beautiful and clean and ran over a gravel bottom. Here on the Wilderness Waterway, our measurements indicated that the dissolved oxygen count was higher than elsewhere in the Missouri. More aquatic life was present, the temperature of the water was lower, and we didn't see any shoreline debris for several days.

Ironically, it is within this area that the Army Corps of Engineers wants to build a new dam, for the ostensible purpose of flood control. They must be hard put for something to do if they plan to build a dam and flood the White Rocks area. If there is any part of the river that doesn't need flood control, it is this one. One really has to look hard to find water damage along these beautiful bluffs. We were encouraged to find National Park Service people scouting the region preparatory to its formal designation as a Wilderness Waterway. This remote acreage has the advantage of relative inaccessibility—a circumstance that may make it possible for the region to maintain a vestige of its wild character for decades. It is accessible by road, mostly gravel, in only three spots. People gain access by floating or canoeing down the river. The waterway is too long to be taken by a motorboat without refueling and this may also serve to preserve the river's wildness.

In traveling through this area, particular spots lend themselves to overnight camping. At these locations, it is distressing to come across hastily buried garbage or toilet tissue scattered in an area of great natural beauty. We reluctantly concluded that at these natural stopovers, inconspicuous pit toilets and flush-to-the-ground garbage receptacles might be needed. These simple precautions would probably be less jarring than the situation that now exists. There is a great need for more camping facilities of all kinds in this country, but especially for the simple type used by the tent camper. For ourselves, we relished the places along this wild stretch where we could escape the radios and electric generators that are becoming common in so many camping areas, and we hope that upon inclusion within the Wild Rivers system, this stretch of the Missouri will be spared the "major improvements" that would only destroy the region's wilderness character.

When we arrived at the Great Falls of the Missouri we were sick with disappoinment. Lewis and Clark had exclaimed over the beauty of this falls, but today a hydroelectric dam curves across the river and holds back water to form a lake that has completely inundated the upper falls. I imagine the electric power and water control were necessary, but couldn't help wondering if a bit more of the falls couldn't have been saved by placing the dam farther upstream.

On July 22 we drew near the extraordinary range of rocks that Lewis and Clark named the Gates of the Rocky Mountains. Their description gives the flavor of their remarkable diaries. Lewis wrote: "For five and three quarter miles these rocks rise perpendicularly from the water's edge to the height of nearly twelve hundred feet . . . nothing can be imagined more tremendous than the frowning darkness of these rocks, which project over the river and menace us with destruction. The river seems to have forced its channel down this solid mass, but so reluctantly has it given way that during the whole distance the water is very deep even at the edges, and for the first

MOUNTAIN TRAVEL (USA)

Mountain Travel (USA) is a different kind of travel organization, established through the combined interests of Barry Bishop (who climbed Mt. Everest with the 1963 American Expedition), Leo Le Bon and Allen Steck (all members of the Sierra Club and American Alpine Club) for the purpose of creating back-country wilderness trips where foot travel is often the only means of access. Emphasis will be on exploration of the many remote areas of our earth that fortunately have yet to be touched by modern civilization. Many of the wild and beautiful places, usually accessible to a few scientists or explorers will be made available to all persons who enjoy hiking and camping in small groups of 15 to 20 persons. Mountain Travel (USA) takes pleasure in announcing the following two trips departing in the winter and spring of 1970:

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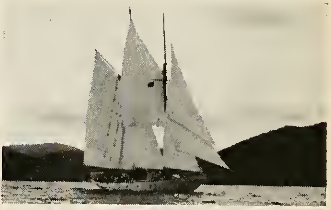

CROWDER NATURE TOURS

SUMMARY: For nine years we have been organizing trips to investigate the Natural History of the world. The program is summarized below; see opposite column for the schedule for coming months. Tours are usually set up in a regional connecting series, so that persons with sufficient time may stay for more than one and save air fare.

— NORTH AMERICA —

The North America program consists of 17 tours, carefully arranged to provide a sampling of the Natural History of the continent. A popular winter trip is Florida; early spring tours are run in Arizona and Texas (the Whooping Cranes and stress on wildflowers). Two 3-week tours, based on geology and emphasizing ecology, go "north with spring" in the Sierras and Cascades. A pair of fall-color tours covers the eastern seaboard and mountains, alternating yearly with a pair of "Basin & Range" tours which start at Nunavik, Northwest Territory, at McKenzie River Delta, and end at Reno, Nevada. Alaska is covered in a series of 3 two-week trips, from the Inside Passage to the Aleutians, Pribilofs and Point Barrow on the Arctic. Newfoundland Labrador and Arctic Canada tours complete the continental coverage.

— MIDDLE AMERICA —

Mexico and Central America, where bird life overshadows all other features, are well covered. Mexico is divided into 7 routes, from Baja California to Yucatan. Three routes in Central America and 3 in the West Indies reach all regions of significance except Cuba.

— SOUTH AMERICA —

Colombia, the world's top country for bird species, is visited twice a year. A series of 5 trips counter-clockwise around South America is featured in "odd" years (1969 etc.) during the Southern Hemisphere spring. Peru and Venezuela are reached annually, and the Galapagos are visited frequently in coordination with Lindblad Travel.

— EUROPE —

There are 12 tours to choose from each year in Europe, and many fine combinations are possible. A series of 3 trips goes north with spring from the Mediterranean to North Cape. Another series of 3 starts at Lisbon and works eastward to the Balkans and Russia, followed by Siberia, Mongolia and on around the world. A fine annual tour is devoted to Britain, and there are 3 Iceland trips a year, including the center and the rarely visited northeast coast.

— ASIA —

Japan and Siberia are visited annually, and a popular series of 5 tours stretches across South Asia in alternate years. China is still out of bounds, but most other Asia regions of significance to naturalists are covered.

— AFRICA —

Africa has been divided into 7 Natural History routes, at least 4 of which are covered each year. Popular East Africa is included, of course, as well as the North Africa coast, Madagascar, the Indian Ocean and other regions.

— SOUTH PACIFIC —

This is one of our top features, with exceptional leadership and captivating itineraries. A full circuit of the Pacific is made in the Southern Hemisphere spring of "even" years, from Hawaii and Melanesia to New Guinea, Australia and New Zealand. Eastern Australia and New Zealand are visited annually.

The above program represents the astounding world coverage now in operation; about 50 of the tours are offered each year. And we still seem not to have lost the friendly, untourist personal touch which we think you'll like.

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three miles there is not a spot except one of a few yards, in which a man could stand between the water and the towering perpendicular of the mountain.

"The convulsion of the passage must have been terrible, since at its outlet there are vast columns of rock torn from the mountain which are strewed on both sides of the river, the trophies as it were of the victory."

The river today is 65 feet higher than it was in 1804, thanks to the construction of Holter Dam by Montana Electric Power. But despite the flooding, some of what Lewis and Clark saw remains in all its magnificence.

We spent much time examining the rock faces there and trying to classify the ferns and flowering plants that managed to get a hold on the perpendicular slopes. Wind and water had combined to create openings in the rocks and these provide shelter for pack rats and other animals. The orange lichen, *Caloplaca*, gives vivid evidence of the presence of the burrows since it is a nitrogen lover and can always be found growing where the urine of the small mammals spills over the rocks or in areas where birds nest in large numbers.

In Montana, we finally left the headwaters of the east-flowing Missouri and transported our canoes westward, over the continental divide to the Clearwater River, a tributary of the Snake. The 200 miles separating the headwaters of the Missouri and Snake dispelled one of the great hopes of the Lewis and Clark expedition—that they would discover an easy water route to the west, which would eliminate the voyage around Cape Horn and bring the Orient half a world nearer. Not only was the portage too long, but neither river was truly navigable in its upper reaches. The Missouri was too shallow and beset by snags and sandbars, the Clearwater too swift and full of rapids.

We rejoined the Lewis and Clark water route on the south fork of the Clearwater and continued downriver, shooting the many rapids until we reached the slack water at Lewiston. Upon arriving at the reservior backed up by the Potlatch Dam, we encountered thousands of pulp logs that had been floated downriver to the Lewiston paper and lumber mills and the railroad yard. We pulled our canoes over to a clear section and continued on our way. Smoke from the paper mills casts a pall over the entire Clearwater Valley. The stench can be smelled for miles. The sulfur waste materials emptied into the river kill many fish and act as corrosives to any exposed metal. Our aluminum canoes literally

CROWDER NATURE TOURS

SCHEDULE: Listed below are starting dates for the next 18 months or so. Space permits only a brief mention of each tour, and one should by all means have the "Tour Catalog" with thumb-nail sketches of each trip, as well as subsequent detailed itineraries. North America tours are 2 weeks each, others 3 weeks, unless otherwise noted.

— 1969 —

SOUTH AMERICA (5 tours)

The five 3-week tours originate in Miami and may be taken separately or in series. Departure dates: Colombia, Aug. 16; Ecuador-Peru, Sep. 6; Chile-Argentina, Sep. 27; Brazil, Oct. 18; Guianas-Venezuela, Nov. 8. Leaders: Dr. D. H. Messersmith and Dr. Carlos Lehmann for Colombia; Richard Crossin for other tours.

SOUTH WITH AUTUMN (2 tours)

Geology and ecology of the eastern U.S.A., following the wave of fall color southward. Northeast Coast tour meets at Bangor Sep. 20; Southeast Coast tour at Harpers Ferry Oct. 11. Leader: Geologist Isabella Coons, with many assisting leaders along the way.

AUSTRALIA — N. Z. (3 tours)

Added by request, Australia tour leaves L.A. Oct. 25; New Zealand Nov. 15; N.Z. West Coast (2 wks) Dec. 6. Xmas party this year on Norfolk Island if you can stay over.

— 1970 —

ASIA (6 tours)

An extraordinary series, perhaps the most exciting we've ever arranged. Departure dates: Indonesia, Jan. 3; Melanesia, Jan. 24; Thailand, Feb. 14; Ceylon-India, Mar. 7; Himalayas, Mar. 28. Also Japan in spring, April 18. Leaders, Crowder and Asia experts.

MIDDLE AMERICA (4 tours)

Following the Florida Tour (from Tallahassee Jan. 10): Yucatan, from Miami Jan. 24; Panama, Feb. 7; Colombia, Feb. 21. Ornithologist, for Cent. America, Irby Davis; Colombia, Dr. Lehmann.

TEXAS — MEXICO (5 tours)

Texas from Corpus Christi March 7; Taxco, Holy Week special; then Mexico West & East Coast.

PACIFIC COAST (7 tours)

Baja California camping, from Nogales Apr. 12; Arizona, from Tucson May 2; Sierras, from San Diego May 16; Cascades, from Klamath Falls, June 6; followed by Alaska South, North and Outposts. Remarkable tropics-to-Arctic coverage of spring in Western North America.

EUROPE (12 tours)

Too much of a program to list here; by all means send for detailed brochure. Norway, Iceland, Russia and Siberia especially recommended. Twelve tours, extending through May, June, July.

CENTRAL AMERICA

Summer program in rainy season when birds are on territory. July and August, 3 tours.

AFRICA (3 tours)

South and East Africa and Madagascar; three tours in July/September. Excellent leadership.

SOUTH AMERICA (4 tours)

Venezuela, Aug. 15; Colombia, Sep. 5; Ecuador/Peru, Sep. 26; Chile/Tierra del Fuego, October 24. Also Galapagos and Antarctica.

SOUTH PACIFIC (8 tours)

This is the year of full South Pacific coverage. Melanesia, Aug. 15 from Samoa; New Guinea, Sep. 5 from Rabaul; Western Australia, Oct. 3 from Perth; Australia East, Oct. 24 from the Barrier Reef at Cairns; New Zealand, Nov. 14 from Auckland; N.Z. West Coast, Dec. 5. Also special tours of New Guinea/West Irian north coast, and Western Australia wildflowers.

BASIN & RANGE (2 tours)

South with Autumn in western North America, starting at Nunavik, N.W.T., Sep. 19; second 3-week leg starts Glacier Park, Oct. 10.

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turned black when we hit this stretch of water. The pollution of the Clearwater is repeated in tributaries of the Columbia so that the river is extremely foul by the time it reaches the Pacific.

The last part of our journey began on the Snake River at Clarkston, Washington. In 1805 the Snake was a large river with many dangerous rapids, but today a great part of the lower river has been turned into a series of slackwater reservoirs.

As we followed the river westward into eastern Washington, the stark beauty of the parched hills reminded us of photos we'd seen of the moon's surface. Black rocks crumble and fall in extensive talus slopes upon which no life exists. It is in this area, where the Palouse River joins the Snake, that Dr. Richard Daugherty of the University of Washington had the Marmes "dig"—the site of the finding of the oldest known man on the North American continent. Archeological excavation has come to a halt here, since the Lower Monumental Dam has backed up water for miles and relegated these remains to oblivion.

The Snake and Columbia rivers are being dammed not only to produce hydroelectric power but also to create a completely navigable waterway, so that the wheat produced in eastern Washington and Oregon can be shipped to the coastal seaports economically—or so we were told. Clearly, the five dams that block these two rivers between Lyons Ferry and Bonneville, Washington, were designed according to the "economies-of-scale" philosophy, which by definition makes no provision for small-scale and noneconomic use of the rivers, such as recreational use.

As we approached the first in this series of dams, there was no one in sight. A chain on the right-hand side of the river channel, facing the lock doors had a sign above it that said "Pull." Karen Jensen, in the bow of the first canoe "pulled," and out of nowhere boomed a voice that seemed to combine the impersonality of an AT&T tape recording and the omnipotence of "big brother": "Do you wish to lock through Miss Small Craft?"

"Yes sir," she replied, somewhat shaken by the voice of the unseen lock attendant. Apparently, the pull chain activated a two-way public address system.

The lower lock doors closed, and water was pumped in to fill the huge locks. The upper doors opened, and we paddled in. The top doors closed and we dropped slowly down 75 feet to the level of the river. The lower gates opened and we left the locks. Some-

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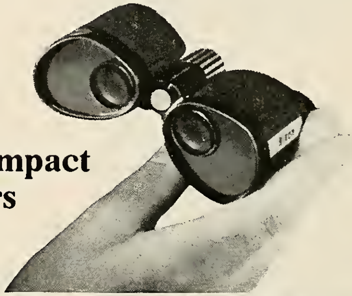

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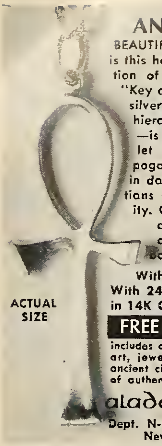

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how, the economies of scale do not hold up when 43,000.000 gallons of water must be pumped into the locks to accommodate two small canoes. I wondered at the cost to the Army Engineers if this river system someday became heavily used by recreational canoeists.

During the early 1800's, the upper reaches of the Snake and Columbia rivers marked the transition zone from the nomadic culture of the Plains Indians to one completely tied to the river and its wealth of salmon. Every conceivable type of weir, spear, and net was used to catch the fish as they made their spawning runs up the river. The fish were split and dried; then pounded or shredded and packed in baskets for winter food along with camass roots. There was very little game of any kind with which to vary the diet. The river was so clear then that "a salmon could clearly be seen at a depth of 20 feet," according to Captain Clark.

Sad to say, the Columbia is now like a dead river, polluted with oil slicks, debris from the pulp mills, and such algae as can grow in this kind of environment, plus domestic sewage all along the way. We were told that fires sometimes break out inside the locks from the accumulation of oil on the sides and surface. This did not make for a relaxed passage through these reservoirs.

In the area between Umatilla, Oregon, and The Dalles, we were struck even more by the little publicized consequences of large-scale inundations. We stopped to enjoy lunch with the people of Roosevelt, Washington, a little town that had existed on the banks of the Columbia when it was a free-flowing river. Now, however, there are two "Roosevelts." During the ten years that the planning and building of John Day Dam was in progress, there was the ever present question of where the new town should be relocated, once the original town was submerged by the dam. Human nature being what it is, and time being on the side of dissension, there was an unmendable breach in relationships among the townspeople—half of them relocated in their favored spot on the north side of the reservoir, while the others settled a mile or so away. Each group now insists that theirs is the "real" Roosevelt. It is always a traumatic experience to be uprooted, and this story is not an uncommon one along the Snake and Columbia.

We approached The Dalles, Oregon, which was the site of Clark's "Great Falls" of the Columbia. These falls were so enormous and rugged as to require a two-day portage. The huge black rocks of the Great Falls formed islands through and around which the

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Columbia waters swirled, and for untold years the Celilo Indians fished from these rocks, dipping and gigging the salmon as the fish hurled themselves up over the stones to reach their spawning grounds.

Until a few years ago the Indians continued the custom of fishing from the Great Falls (now Celilo Falls), with only the addition of scaffolding perched precariously on the rocks. Today, due to flooding of the falls by the backwater of the Dalles Dam, the fishing is ended. In 1956, when the fishing rights of the Celilo Indians were purchased prior to the flooding, part of the formal agreement was that when their chief died, his body was to be transported to the sacred burial ground by a route that would not pass within sight of the dam. This request typifies the attitude of the Celilos toward the dam and its reservoir. His request was honored at considerable cost and effort to the Corps of Engineers, and included the construction of some small bridges.

With few exceptions the people we talked with—Indians and whites alike—spoke sadly of the beauty and significance of the lost falls, and wondered if the electric power and ease of navigation gained balanced the esthetic splendor and cultural heritage lost. I too wondered how society determines the net gain of such fantastic impoundment. When we consider that the life of one of these huge reservoirs is not much beyond 200 years, and sometimes less, how can we truly determine if the economic gains from such a structure outweigh the value of leaving an area in a natural state, especially when society's long-term needs are in fact unknown. When you look at the desecration of these once magnificent rivers, it is easy to question the validity of the great economic yardstick.

On August 12 we drove from the Columbia into Portland, Oregon, for a luncheon with Governor Tom McCall. The Governor presented us with a citation, and promised that if we made our journey again in five years, we'd find the Willamette River (which flows through the capital into the Columbia) "among the cleanest" rivers in the country. At present there are large numbers of houseboats permanently anchored all along this river, and the Willamette acts as an open sewer that gets thoroughly flushed only about once a year when the spring floods come. Governor McCall has formed a commission to study the problems of enforcing antipollution laws and has made himself head of the group in order to put teeth into any legislation enacted. It will indeed be interesting to see if he can live up to his promise.

Finally past the last dam, we canoed down the swift currents of the Columbia, battered by the tidal influence of the Pacific. I was reminded of how Captain Clark described the last few miles of his journey: "The tide meeting of me and the emence swells from the main ocian (imedeatly in front of us) raised to such a hite that I concluded to form a camp on the highest spot I could find in the marshy bottom and proceed no further by water as the coaste becomes verry dangerous for crafts of the size of our canoes."

We arrived at the mouth of the Columbia at 11:00 A.M., August 15, and were met by Governor Daniel Evans of the state of Washington and the president of our own Charles County Community College, J. N. Carsey, and his wife. The canoes were lifted to shore by a gentle wave and came to rest on the beach at Cape Disappointment, marking the end of our 3,400-mile journey.

As we stepped from our canoes, I felt the array of emotions that visit any traveler at the end of an adventure: elation, satisfaction, depression, excitement. But perhaps most important, our whole crew, I believe, had attained a new awareness of our country and the people who populate it. After landing, I spoke a few words of our trip to the press. I do not remember what they were; they were probably unimportant. I'm sure they did not properly convey the personal significance of our retracing of the Lewis and Clark route. But if I were again presented with the opportunity to speak my thoughts, I believe I would remind our audience of Captain Lewis's enthusiasm for the "opening" of the West, and of the rapidity with which it was opened and transformed by the push of population and economics. In the 165 years since Lewis and Clark, beaver, buffalo, clean free-flowing rivers, and natural landscapes have become relatively scarce commodities while the man-caused phenomena—from water pollution to hydropower dams—are daily increasing. In many cases, this transformation has proceeded according to the dictates of short-term expediency and without a judicious regard for the future. Our trip, our observations and conversations, revealed to us the consequences and predominance of the set of values that give rise to this type of action. But it also alerted us to the beauty and adventure which is still abundant in the west, and therefore to the need for social priorities. It would be nice to believe that a future retracing of our route could be performed—say in another 165 years—with the participants still able to sense something of the land, the water, the air, the flora and fauna, and the spirit that surrounded the early expedition in the time of Lewis and Clark. ☐

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Books In Review

PERSEPOLIS, by Donald N. Wilber. *Thomas Y. Crowell Co., $7.95; 120 pp., illus.*

This excellent, well-illustrated book on the royal Persian site of Persepolis serves both scholar and layman. A succinct review of the current state of our knowledge about this sacred city, and the dynasty that built it, the slender volume is packed with information that is written with authority, ease, and clarity.

The great terrace, 1,400 feet long and 1,000 feet deep, was built in the sixth and fifth centuries B.C. by the Persian kings who ruled almost all the Near East and was destroyed by Alexander the Great in 330 B.C. On the leveled platform—raised forty feet or more above the surrounding plain in the modern province of Fars, in southwest Iran—are the ruins of palaces, audience halls, storage buildings, gatehouses, and hundreds of feet of delicately carved reliefs showing long processions of Persians and foreign tributaries. Although these spectacular remains were known to travelers for centuries, and finally became the object of extensive archeological excavation by an American expedition in the 1930's, the story of Persepolis has hitherto been scattered in the professional literature. Now we have, for the first time in English, a readable survey exclusively devoted to this site.

The book begins with a reconstruction of the history of the Persians, from their shadowy beginnings in the Persian and Median clans that filtered into Iran as part of the southerly movement of the Indo-Iranian language groups, to the collapse of the dynasty under the spears of Alexander's Macedonian troops. Wilber shows how, step-by-step, modern investigations have reconstructed the past from bits and pieces of archeological and philological evidence, and how this material can be interpreted to form the mosaic of history. Thus, he permits the reader to share in the pleasure of creating a unified picture. Next, he describes each of the main structures at Persepolis—or Parsa as the ancient Persians may have called the site—and then follows this with a discussion of the sculptural remains.

He notes several of the seemingly minor unknowns that prick our historical conscience, reminding us how little we actually know of this imperial headquarters. Why, for example, do the stairways and thresholds show almost no wear although the terrace was in use for over two centuries? Why were some of the panels reserved for royal inscriptions left bare? Why was some of the architectural decoration never finished? Why did the Greeks, who wrote at length about the Persian Empire, hardly mention this impressive citadel? Indeed, we are not even certain of the purpose for which this ancient complex was built.

BERNARD GOLDMAN
Wayne State University

WHAT'S LEFT: REPORTS ON A DIMINISHING AMERICA, by Berton Roueché. *Little, Brown and Co., $5.95; 210 pp.*

During the past seven years Mr. Roueché has traveled into some fascinating places. *What's Left*, as he calls his *Reports on a Diminishing America*, consists of his chronicles of a launch trip to "The Last of the Keys" in Florida; a formidable voyage in an Eskimo dory (called an umiak) from Nome to King Island in the Bering Strait; a furious boat ride down the Green River in Wyoming; an invasion in a Scout motorcar into the Sonoran desert in southern Arizona; a boat ride down Current River in the Ozarks; an automobile ride in the Big Thicket of east Texas where some natives, for spite, have poisoned a mammoth beech tree thought to be one thousand years old.

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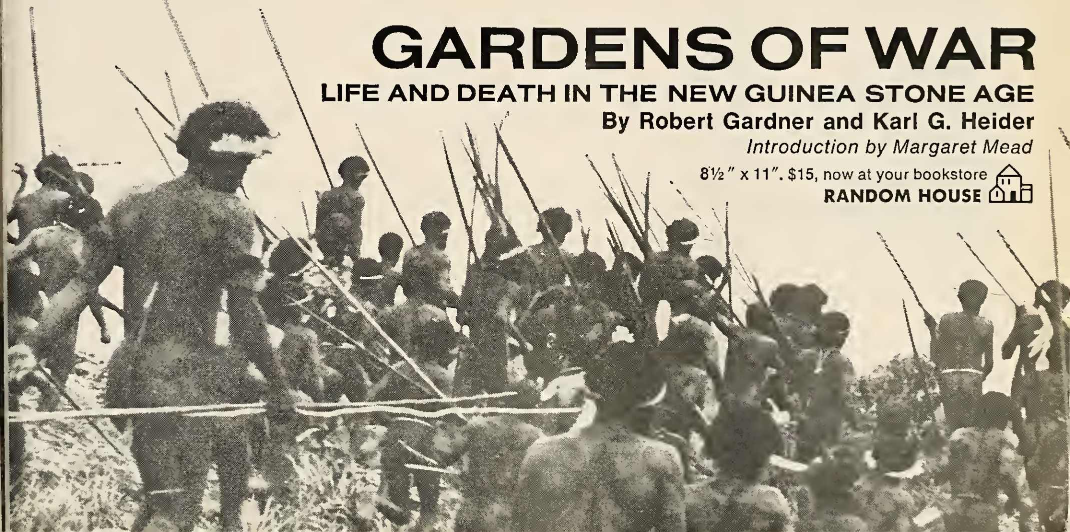

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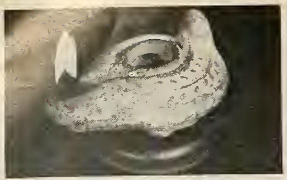

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areas that are parts of the national park and monument systems, or that would be desirable additions, and most of them were in the company of rangers and professional outdoorsmen who know the territory.

To sit in the perpendicular jungle of New York City and read Mr. Roueché's reports of the outdoors in remote places is to be profoundly envious. It excites a city dweller's imagination to learn that the seeds of desert annuals in Arizona are covered with a water-resistant skin, which is impervious to showers but dissolves in rains heavy enough to ensure germination; that moose and elk live with some security along the Green River; that Ivory-billed and Pileated Woodpeckers live close by in the east Texas Thicket; that eider ducks congregate by the thousands in Bering Strait. The subjects of the narratives are heady stuff.

Was Mr. Roueché as excited as the reader? The question is asked because his style is flat. Although he writes in the first person, there is almost no sense of personality in his pages. He does remark that he was so giddy when he looked down from the face of a steep mountain in Arizona that he could not enjoy the view! "All I could think about was the climb back down," which was, indeed, alarming. But Mr. Roueché has his emotions so firmly under control that he takes most of his adventures in stride. Nature is wild, but Mr. Roueché's style is totally civilized.

Since he is a brilliant observer and a meticulous recorder, the reader respects his enterprise, alertness, and knowledge and—one might add—his modesty. His casual style represents his taste in narrative. He is a staff writer for the *New Yorker* in which good style is limp and bland, affable, gentlemanly, and bloodless. Mr. Roueché writes simple, declarative sentences, like Ernest Hemingway without the tensions. He is scrupulous with facts. He communicates impressions without using emotional words.

If that is the way Mr. Roueché wants to write, credit him with perfection. There is not a slovenly sentence in his book. But writing in a low key about grand places and startling adventures involves some solemn statements of the obvious, like "The organ-pipe [cactus] looked a lot like organ pipes." Mr. Roueché uses dialogue to make transitions informally and to support the casual mood, but the dialogue can also be pointless:

"How are you doing?" Bullard said.

The warden smiled. "We're getting some rice," he said.

"So I see," Bullard said.

Writing that appears to be as effortless as this is the result of great effort. Mr. Roueché is not a careless writer. But the style neutralizes the theme. In his book, *What's Left*, nature is drained of wildness.

Brooks Atkinson
Author and Critic

The Geography of Life, by Wilfred T. Neill. *Columbia University Press, $12.95; 480 pp., illus.*

Zoogeography and phytogeography are generally, and understandably, treated as independent subjects, since animals and plants have different methods of dispersal, different histories, and are usually studied by different people. Wilfred Neill has attempted to put the two together by writing a "geography of life." The title, however, is overly ambitious because the author restricts himself to vertebrates and seed plants, and gives almost all his attention to terrestrial organisms, with only a rather cursory glance at life in inland waters and in the seas.

His accomplishment is to juxtapose the patterns of distribution shown by vertebrates and seed plants, thus bringing out both the similarities and the differences without really trying to develop any unified or general system for geographical classification and description. His major categories for animals are "realms" and "regions"; for plants, "kingdoms" and "provinces." The lands of the planet are divided among three realms for the animals, and six kingdoms for the plants—a schizoid approach that seems confusing to me, however useful it may be for purposes of analysis.

Both the plants and the animals of Australia and South America stand out as different from those inhabiting other continental lands. We all know about Australia, with its kangaroos and eucalypti. South America is less obviously peculiar, but it was just as isolated as Australia through most of recent geologic history when modern animal and plant types were evolving; and in any listing of species, genera, and families, it turns out to have a similar proportion of peculiarities.

For vertebrate animals, Neill groups all of the other continental areas into a single "Eurasian-African-North American Realm." For seed plants, however, he distinguishes among the "Paleotropical," "Boreal," and "Antarctic" kingdoms. The very tip of South Africa has so many peculiar plants that he ranks this as a distinct "Cape Kingdom."

Certainly the author has managed a dramatic survey of the diversity of present conditions of life on our planet, viewed in the perspective of geologic history. The text is lavishly illustrated with photographs of animals and plants, although I wish more maps had

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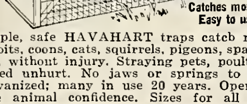
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been included. There is frequent reference to the personalities involved in the history of biogeography, and to the various theories that they have developed. In a final chapter the author glances briefly at the geography of *Homo sapiens*, and at the effect of human activities on the distribution of other organisms—now the most important influence of all on the history of the biosphere.

MARSTON BATES
University of Michigan

Briefly Noted:

JOURNEY TO RED BIRDS, by Jan Lindblad. *Hill and Wang, $6.50; 176 pp., illus.*

Jan Lindblad, accomplished storyteller and wildlife photographer, provides a fast-moving account of his experiences photographing the animals of Trinidad and the nearby islands. Complementing Mr. Lindblad's story are his beautiful color photographs of the exotic wildlife of the tropical rain forest—the scarlet ibis, hummingbird, spoonbill, vampire bat, and assorted snakes. Mr. Lindblad wrote "Birds of Darkness," NATURAL HISTORY, February, 1969, which described the oilbirds of Trinidad.

RARE SHELLS, by S. Peter Dance. *University of California Press, $17.00; 128 pp., illus.*

Intended as a companion volume to the author's earlier book *Shell Collecting: An Illustrated History*, this work concerns the subject of rare shells only. Mr. Dance examines the cult of rarity and traces the history of rare shell collecting from its earliest beginnings to the present practice of "live-collecting" by use of the aqualung. A description of 50 shells, all of them illustrated in color, completes the volume.

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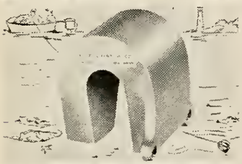

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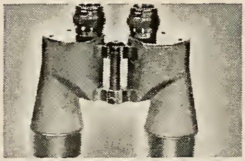

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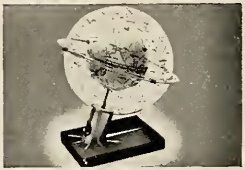

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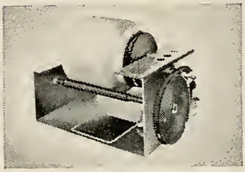

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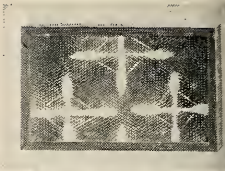

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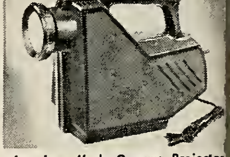

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THE LAST LANDSCAPE. W. H. Whyte. Doubleday & Co., Inc., Garden City, 1968.

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ARTS AND CRAFTS OF HAWAII. Te Rangi Hiroa (P. H. Buck). Bernice P. Bishop Museum Special Publication #45, Honolulu, 1957.

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RAREST BOOBY

SOCIAL BEHAVIOR IN ANIMALS. N. Tinbergen. John Wiley and Sons, Inc., New York, 1953.

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LIVING REPTILES OF THE WORLD. K. P. Schmidt and R. F. Inger. Hanover House, Garden City, 1957.

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THE FLORENCE FLOODS

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MAN AND NATURE. G. P. Marsh. D. Lowenthal, ed. Harvard University Press, Cambridge, 1965.

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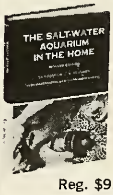

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Mary Carnwath works and ives two thousand miles away, in Manhattan. Her own daughter is now grown-up, and through *Save the Children Federation* she is sponsoring one of the village girls, 8-year-old Grace Mahtewa.

The Mahtewas (two parents, hree children, one grandmother and a sister-in-law) live tightly packed in a tiny rock and mud house. The father who knows ranch work but can't find any most of the year, isn't able to provide the family with even the bare necessities.

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Natural History

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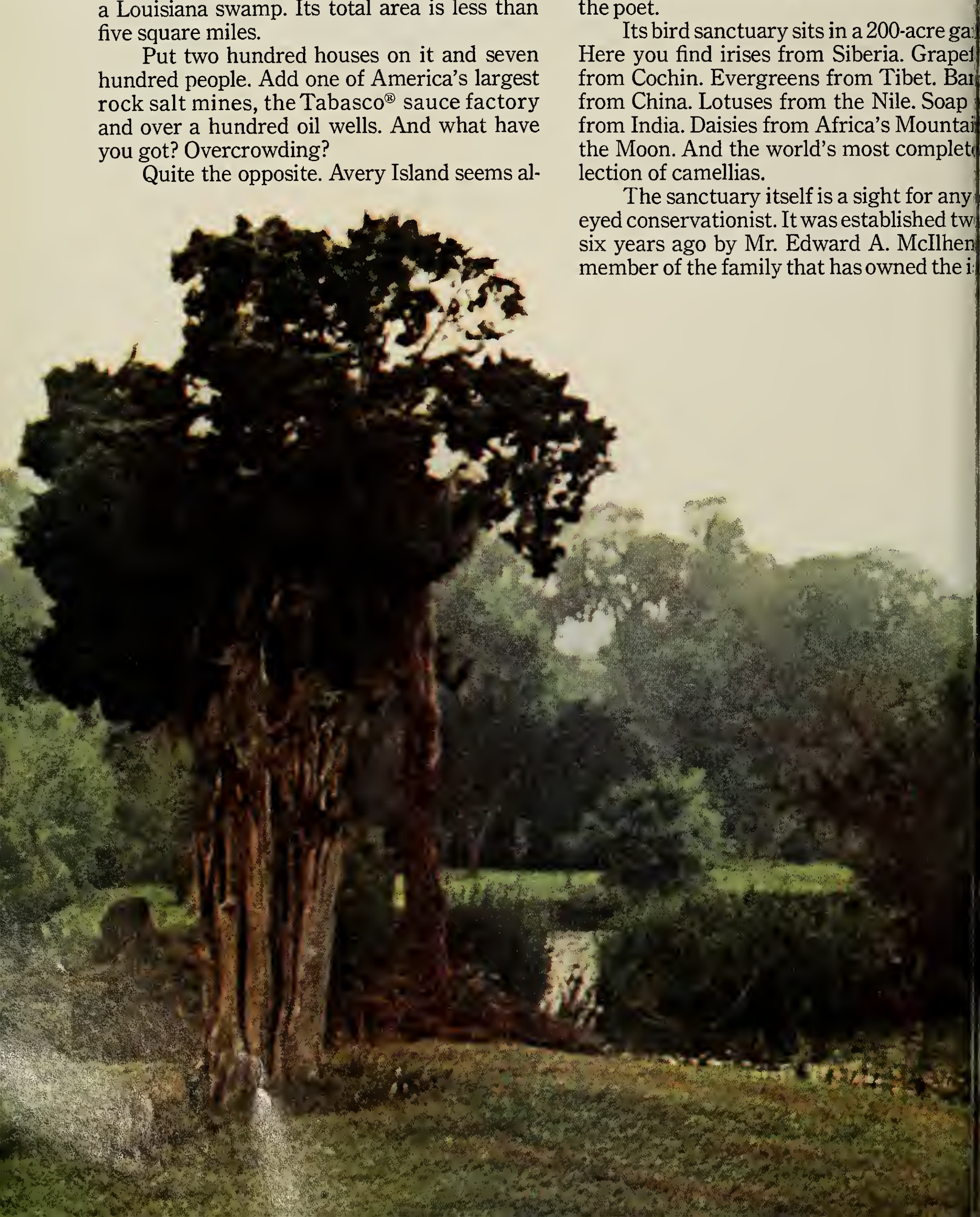

an oil field.

2 years. It had one purpose. To save the y egret from extinction.

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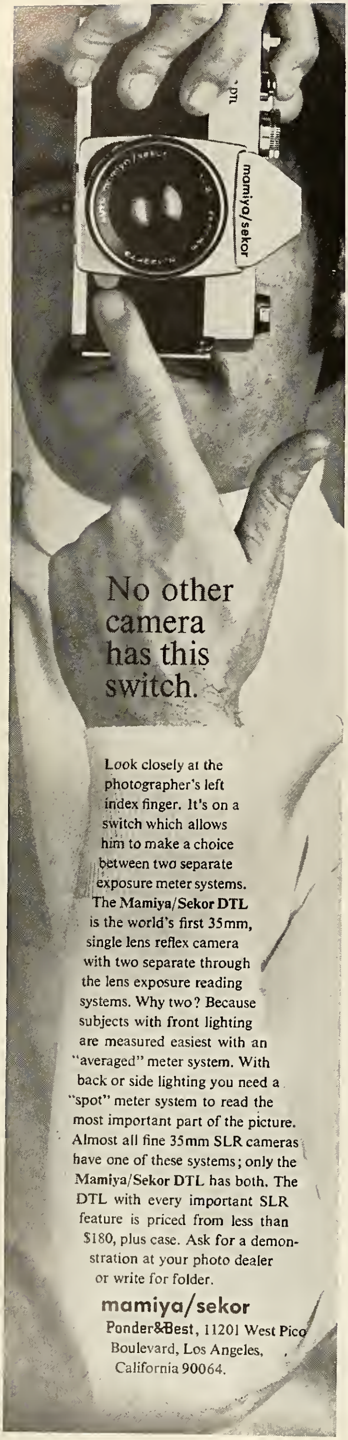

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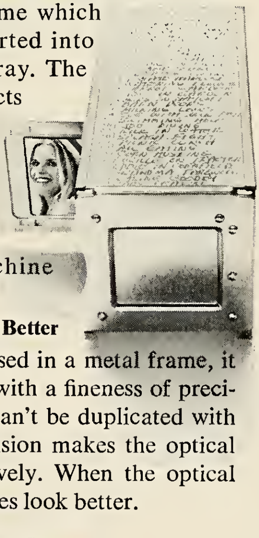

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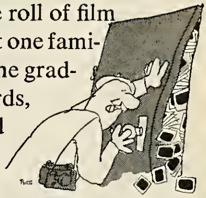

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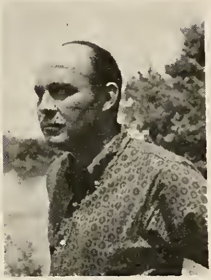

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Claudia Andujar

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THE AUTHORS

LOREN EISELEY is Benjamin Franklin Professor of Anthropology and the History of Science at the University of Pennsylvania; he also serves as Curator of Early Man at the University Museum. His article, "The Innocent Fox," is taken from his latest book, *The Unexpected Universe*, published this month by Harcourt, Brace & World. The book deals with unexpected twists in the evolutionary process on our planet. Dr. Eiseley. a member of the National Parks Advisory Board. the National Committee on Secondary Education. and the Advisory Board of the National Book Awards Committee, has received honorary degrees in both science and literature.

Assistant Professor of Education at San Fernando Valley State College in California, IRA J. WINN combines an interest in educational curricula reform with problems of conservation and urbanism—the subject of his "Naturalist at Large" column. Dr. Winn is currently serving as an advisor on secondary education and educational planning in Brazil and has helped develop civic education programs at UCLA and Columbia University.

JAMES H. CARMICHAEL. JR., the author of "Jumping Spiders," first appeared in NATURAL HISTORY in the June-July issue as a finalist in this year's photographic competition, "Nature and the Camera." Although his academic and professional background is in anthropology, Mr. Carmichael has been seriously interested in color macrophotography for many years. Beginning in 1956, he spent four years in Mexico doing field work in cultural anthropology, during which time he collected and photographed jumping spiders. Mr. Carmichael hopes to expand his research into a color-illustrated publication on the beauty of spiders.

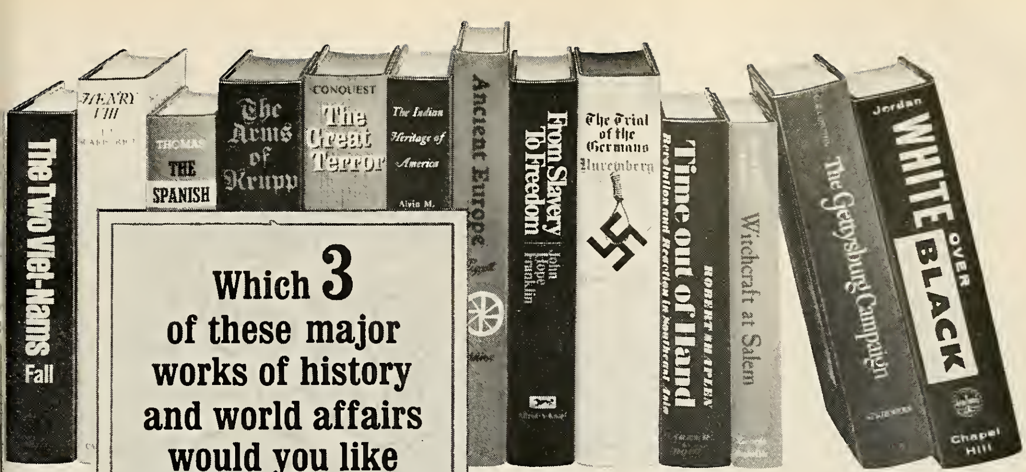
LUNA B. LEOPOLD, a Senior Research Hydrologist with the U.S. Geological Survey, has worked principally in the western states—including Hawaii and Alaska. He has degrees in physics and meteorology, civil engineering, and geology. A member of the National Academy of Sciences, he is coauthor of *The Flood Control Controversy* and *Fluvial Processes in Geomorphology* Dr. Leopold is currently heading an interdepartmental committee that is preparing a report on the potentia effects of a jetport under construction just north of Everglades National Park in Florida.

Raised in the mountain region o eastern Tennessee, H. LEA LAWRENC spent three-and-a-half years as Chie of Public Relations for the Tennessee Game and Fish Commission Since that time, he has been a freelance writer-photographer for outdoor, general, and scientific publications. Previously published i NATURAL HISTORY with an article o ginseng, the alleged aphrodisia herb, Mr. Lawrence is presently affiliated with *Southern Living*, and i field editor for *Outdoor Life*.

Assistant Professor of Social Anthropology at the University of Chicago, TERENCE S. TURNER receive his Ph.D. from Harvard in 1965 Between 1962 and 1966 he spent tw years in central Brazil among th northern Kayapo tribe, to which th Tchikrin belong. Although D Turner has never visited the villag in which the photographs for hi article were taken, the communitie he studied contained a sizable grou of Tchikrin immigrants. Dr. Turne is the author of the forthcomin book, *The Fire of the Jaguar*.

The pictures of the Tchikrin wer taken by CLAUDIA ANDUJAR. a Brazilian photographer whose work ha appeared in *Life*, *Look*, and at Ne York's Museum of Modern Art.

An executive producer for NB News, ROBERT NORTHSHIELD too advantage of an assignment in Hawaii to explore the 1,000-mile islan arc known as the Leewards. H studied zoology at Knox College bu moved directly into journalism, fir on Chicago newspapers and no with network television. Mr. Northshield devotes his free time to bir watching and photography. and now taking the pictures and writin the text for a book on the goals an achievements of the National Wildlife Refuges.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Letters to the Editor

Natural Historians and Worm Runners

In your August-September issue you describe the problems of computerizing your mailing list and warn your readers that, "at worst, they will receive no copies of NATURAL HISTORY but, instead, a combined bill for seven years of Ladies Home Journal, the Worm Runner's Digest, and the East Indian Philately." Computers are admittedly funny things, but then, so is our Digest. When we went the computer route ourselves some time ago, however, none of our readers ended up getting billed for a seven-year subscription to NATURAL HISTORY. Perhaps modern computers have graduated from having the "bugs" that you describe and are having "worms" instead.

Welcome to the 20th Century!

JAMES V. MCCONNELL
Editor, The Worm Runner's Digest

Wilderness Economics

As an economist concerned with problems of conservation and outdoor recreation, I read with interest Garrett Hardin's "The Economics of Wilderness" in your June-July, 1969 issue. It seems to me that Dr. Hardin has made a contribution by viewing these problems as economic, i.e., as problems in the allocation of scarce resources among a variety of objectives. I would like to add a few comments on some of his specific points.

First, we might usefully enlarge the theoretical perspective that Hardin proposes to consider not only allocation of scarce resources among park-type activities, but also between broader types of activities, such as the "extractive" activities (logging, mining, etc.) versus the "park" activities (preservation of natural environments and provision of mass recreation).

Second, the notion of a fixed "carrying capacity" for an area is not well-defined. It is clear, however, that a sort of "law of diminishing benefits" associated with increasing use does imply limits for the levels of optimal use in a given area.

Third, with respect to the method of limiting access to wilderness areas, there is an objection—in addition to the ones Hardin mentions—to the "queue" method of wilderness rationing. As Dr. Hardin observes, there is some question of fairness in allocating wilderness by means of a price tag, in that this method discriminates against those with low incomes. Rationing by queue, however, contrary to Dr. Hardin's assertion, could also be considered unfair in that it discriminates against those with a high opportunity cost of time, i.e., those with high earnings, since these people could have used the time spent "waiting in line" to produce a high amount of income for themselves. Queues are also economically wasteful in that the opportunity cost of waiting is not returned to society in any way.

A "merit" system of access would seem to have much to recommend it. I would offer just one criticism, or amendment to the graded and administered system proposed by Dr. Hardin. Like many other noble experiments, it could be excessively bureaucratic and difficut to enforce. Why not simply a *de facto* merit access system? That is, let us not install any facilities for mechanized access to an area reserved for wilderness. This would help accomplish the objective of preservation while not opening the door to abuses.

ANTHONY C. FISHER
Assistant Professor of Economics
Brown University

Garrett Hardin's article on "The Economics of Wilderness" was fascistic. Everyone pays taxes. Therefore the wilderness should belong to everyone. He wants to limit it to those who live near the wilderness. Those who live in the East cannot afford to fly West each vacation for a backpacking trip. Most of us can, however, go West once in a lifetime, and on that one western trip we want to see the most we can. I went to California in June for the first time in my life. I had spent a year planning the trip so we could alternate hiking and riding so neither would be too fatiguing, and so we could drink in the most beauty in three weeks.

We spent two and one-half days in Yosemite. It was the highlight of a varied and wonderful trip. If it had not been for good roads and the conveniences that Hardin deplores, we could not have seen so much in such a short time. I especially enjoyed the short, but difficult climb to Sierra Point where we could see five waterfalls at once. Later that evening I saw a man in a wheelchair contemplating Yosemite Falls. Should he be denied the view of Yosemite Falls because he could not climb as high as I?

Parks are not destroyed by too many people using them, but by ignorant or destructive people abusing them. Yosemite Valley was crowded, but the ranger said that the back country was almost empty. Those who have the time and energy can find the solitude they want away from the crowded camp. I rejoiced that I lived in a rich country where so many people could visit such a lovely spot. I was thrilled to see Americans of all colors and many people from other countries enjoying such beauty. I was delighted at the variety of people with varied camping gear around me. On one side was a colorful, quiet group of hippies with their peacefully coexisting dog and cat. On the other side was a nice, elderly couple with a tiny sleeping tent and a dressing tent made from a shower curtain and stall. Behind us was a couple from the Midwest who had no tent at all. They slept in the car. We were happy that we had a nice self-contained trailer, but we were glad to see others enjoying the park with the equipment they had. Everyone was quiet, including the dog and cat. Everyone was clean, including the hippies. I was even pleased to see the rich, old people sitting on the porch at the lodge.

I especially liked seeing mothers with young children on the easy paved trails. Young children are often boring, but parents who take them camping are rewarded by seeing them grow up to be conservationists. I have been taking my son camping and on nature walks since he was two. He would not have the love of nature he now has if he had not been exposed to it in our eastern parks. Now he is a far better hiker than I, and he enjoys backpacking in the Blue Ridge Mountains, which his working parents do not have the time to do.

We were glad that we had time to camp and hike, but we were also glad that the people who only drove through were enjoying it. I was so pleased to see a Japanese-American reading the descriptive signs and then translating them to his Japanese mother. I certainly would not want them denied this pleasure.

I will never be strong enough for a backpacking trip. A few years ago my health was so bad I could hardly walk. Even now I must wear special shoes and stockings in order to walk. Yet one of the things that has helped me become stronger has been our camping trips in the East. On each trip I walk farther. I do not want any fascist government denying me the right to visit the cool mountains where I am free from pain.

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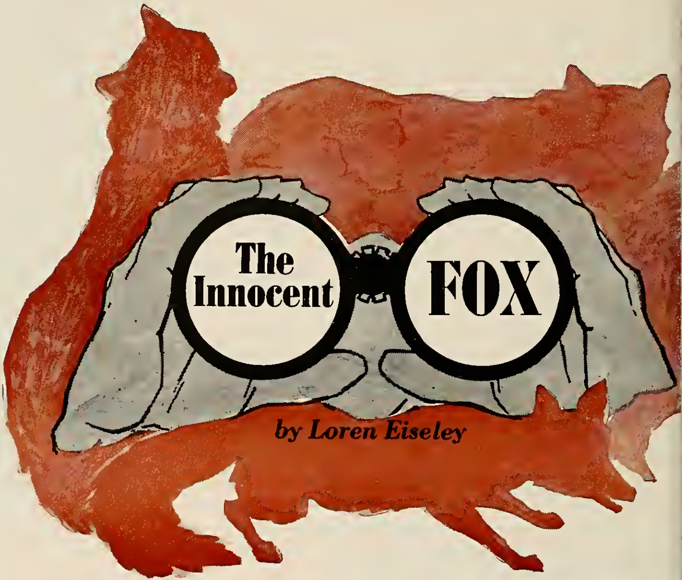
The Innocent FOX

by Loren Eiseley



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An autumn midnight in 1967 caught me staring idly from my study window at the attic cupola of an old Victorian house that loomed far above a neighboring grove of trees. I suppose the episode happened just as I had grown dimly aware, amidst my encasing cocoon of books and papers, that something was missing from my life. This feeling had brought me from my desk to peer hopelessly upon the relentless advance of suburban housing. For years, I had not seen anything from that particular window that did not spell the death of something I loved.

Finally, in blundering, good-natured confidence, the last land tortoise had fallen a victim to the new expressway. None of his kind any longer came to replace him. A chipmunk that had held out valiantly in a drainpipe on the lawn had been forced to flee from the usurping rats that had come with the new supermarket. A parking lot now occupied most of the view from the window. I was a man trapped in the despair once alluded to as the utterly hopeless fear confined to moderns—that no miracles can ever happen. I considered, as I tried to will myself away into the attic far above the trees, the wisdom of a search, a search unlikely to yield tangible results.

Since boyhood I have been charmed by the unexpected and the beautiful. This was what had led me originally into science, but now I felt instinctively that something more was needed—though what I needed verged on a miracle. As a scientist, I did not believe in miracles, though I willingly granted the word broad latitudes of definition.

My whole life had been unconsciously a search, and the search had not been restricted to the bones and stones of my visible profession. Moreover, my age could allow me folly; indeed, it demanded a boldness that the young frequently cannot afford. All I needed to do was to set forth either mentally or physically, but to where escaped me.

At that instant the high dormer window beyond the trees blazed as blue as a lightning flash. As I have remarked, it was midnight. There was no possibility of reflection from a street lamp. A giant bolt of artificial lightning was playing from a condenser, leaping at intervals across the interior of the black pane in the distance. It was the artificial lightning that only one or several engineers with unusual equipment could produce.

Now the old house was plebeian enough. Rooms were rented. People of modest middle-class means lived there, as I was to learn later. But still, in the midmost of the night, somebody or some group was engaged in that attic room upon a fantastic experiment. For, you see, I spied. I spied for nights in succession. I was bored, I was sleepless, and it pleased me to think that the mad scientists, as I came to call them, were engaged, in their hidden room, upon some remarkable and unheard-of adventure.

Why else would they be active at midnight, why else would they be engaged for a brief hour and then extinguish the spark? In the next few days I trained high-powered field glasses upon the window, but the blue bolt defeated me, as did the wavering of autumn boughs across the distant roof. I could only believe that science still possessed some of its old, mad fascination for a mind outside the professional circle of the great laboratories. Perhaps, I thought eagerly, there was a fresh intelligence groping after some secret beyond pure technology. I thought of the dreams of Emerson and others when evolution was first anticipated but its mechanisms remained a mystery entangled with the first galvanic batteries. Night after night, while the leaves thinned and the bolt leaped at its appointed hour, I dreamed, staring from my window, of that coruscating arc revivifying flesh or leaping sentient beyond it into some unguessed state of being. Only for such purposes, I thought, would a man toil in an attic at midnight.

I began unconsciously to hang more and more upon that work of which, in reality, I knew nothing. It sustained me in my waking hours when the old house, amidst its yellowing leaves, assumed a sleepy and inconsequential air. For me, it had restored wonder and lifted my dreams to the height they had once had when, as a young student, I had peeped through the glass door of a famous experimenter's laboratory. I no longer read. I sat in the darkened study and watched and waited for the unforeseen. It came in a way I had not expected.

One night the window remained

dark. My powerful glasses revealed only birds flying across the face of the moon. A bat fluttered about the tessellated chimney. A few remaining leaves fell into the dark below the roofs.

I waited expectantly for the experiment to be resumed. It was not. The next night it rained violently. The window did not glow. Leaves yellowed the wet walks beneath the street lamps. It was the same the next night and the next. The episode, I came to feel, peering ruefully from my window, was altogether too much like science itself—science with its lightning bolts, its bubbling retorts, its elusive promises of perfection. All too frequently the dream ended in a downpour of rain and leaves upon wet walks. The men involved had a way, like my mysterious neighbors, of vanishing silently and leaving, if anything at all, corroding bits of metal out of which no one could make sense.

I had once stood in a graveyard that was a great fallen city. It was not hard to imagine another. After watching fruitlessly at intervals until winter was imminent, I promised myself a journey. After all, there was nothing to explain my disappointment. I had not known for what I was searching.

Or perhaps I did know, secretly, and would not admit it to myself: I wanted a miracle. Miracles, by definition, are without continuity, and perhaps my rooftop scientist had nudged me in that direction by the uncertainty of his departure. The only thing that characterizes a miracle, to my mind, is its sudden appearance and disappearance within the natural order, although, strangely, this loose definition would include each individual person. Miracles, in fact, momentarily dissolve the natural order or place themselves in opposition to it. My first experience had been only a tantalizing expectation, a hint that I must look elsewhere than in retorts or coiled wire, however formidable the powers that could be coerced to inhabit them. There was magic, but it was an autumnal, sad magic. I had a growing feeling that miracles were particularly concerned with life, with the animal aspect of things.

Just at this time, and with my thoughts in a receptive mood, a summons came that made it necessary for me to make a long night drive over poor roads through a dense forest. As a subjective experience, which it turned out to be, I would call it a near approach to what I was seeking. There was no doubt I was working further toward the heart of the problem. The common man thinks a miracle can just be "seen" to be reported. Quite the contrary. One has to be, I was discovering, reasonably sophisticated even to *perceive* the miraculous. It takes experience; otherwise, more miracles would be encountered.

One has, in short, to refine one's perceptions. Lightning bolts observed in attics, I now knew, were simply raw material, a lurking extravagant potential in the cosmos. In themselves, they were merely powers summoned up and released by the human mind. Wishing would never make them anything else and might make them worse. Nuclear fission was a ready example. No, a miracle was definitely something else, but that I would have to discover in my own good time.

Preoccupied with such thoughts, I started my journey of descent through the mountains. For a long time I was alone. I followed a road of unexpectedly twisting curves and abrupt descents. I bumped over ruts, where I occasionally caught the earthly starshine of eyes under leaves. Or I plunged at intervals into an impenetrable gloom buttressed by the trunks of huge pines.

After hours of arduous concentration and the sudden crimping of the wheel, my eyes were playing tricks with me. It was time to stop, but I could not afford to stop. I shook my head to clear it and blundered on. For a long time, in this confined glen among the mountains, I had been dimly aware that something beyond the reach of my headlights, but at times momentarily caught in their flicker, was accompanying me.

Whatever the creature might be, it was amazingly fleet. I never really saw its true outline. It seemed, at times, to my weary and much-rubbed eyes, to be running upright like a man, or, again, its color appeared to shift in a multiform illusion. Sometimes it seemed to be bounding forward. Sometimes it seemed to present a face to me and dance backward. From weary consciousness of an animal I grew slowly aware that the being caught momentarily in my flickering headlights was as much a shapeshifter as the wolf in a folk tale. It was not an animal; it was a gliding, leaping mythology. I felt the skin crawl on the back of my neck, for this was still the forest of the windigo and the floating heads commemorated so vividly in the masks of the Iroquois. I was lost, but I understood the forest. The blood that ran in me was not urban. I almost said not human. It had come from other times and a far place.

I slowed the car and silently fought to contain the horror that even animals feel before the disruption of the natural order. But was there a natural order? As I coaxed my lights to a fuller blaze I suddenly realized the absurdity of the question. Why should life tremble before the unexpected if it had not already anticipated the answer? There was no order. Or, better, what order there might be was far wilder and more formidable than that conjured up by human effort.

It did not help in the least to make out finally that the creature who had assigned itself to me was an absurdly spotted dog of dubious affinities—nor did it help that his coat had the curious properties generally attributed to a magician. For how, after all, could I assert with surety what shape this dog had originally possessed a half mile down the road? There was no way of securing his word for it.

The dog was, in actuality, an illusory succession of forms finally, but momentarily, frozen into the shape "dog" by me. A word, no more. But as it turned away into the night how was I to know it would remain "dog"? By experience? No, it had been picked by me out of a running weave of colors and faces into which it would lapse once more as it bounded silently into the inhuman, unpopulated wood. We deceive ourselves if we think our self-drawn categories exist there. The dog would simply become once more an endless running series of forms, which would not, the instant I might vanish, any longer know themselves as "dog."

By a mental effort peculiar to man, I had wrenched a leaping phantom

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into the flesh "dog," but the shape could not be held, neither his nor my own. We were contradictions and unreal. A nerve net and the lens of an eye had created us. Like the dog, I was destined to leap away at last into the unknown wood. My flesh, my own seemingly unique individuality, was already slipping like flying mist, like the colors of the dog, away from the little parcel of my bones. If there was order in us, it was the order of change. I started the car again, but I drove on chastened and unsure. Somewhere something was running and changing in the haunted wood. I knew no more than that. In a similar way, my mind was leaping and also changing as it sped. That was how the true miracle, my own miracle, came to me in its own time and fashion.

The episode occurred upon an unengaging and unfrequented shore. It began in the late afternoon of a day devoted at the start to ordinary scientific purposes. There was the broken prow of a beached boat subsiding in heavy sand, left by the whim of ancient currents a long way distant from the shifting coast. Somewhere on the horizon wavered the tenuous outlines of a misplaced building, growing increasingly insubstantial in the autumn light.

After my companions had taken their photographs and departed, their persistent voices were immediately seized upon and absorbed by the extending immensity of an incoming fog. The fog trailed in wisps over the upthrust ribs of the boat. For a time I could see it fingering the tracks of some small animal, as though engaged in a belated dialogue with the creature's mind. The tracks crisscrossed a dune, and there the fog hesitated, as though puzzled. Finally, it approached and enwrapped me, as though to peer into my face. I was not frightened, but I also realized with a slight shock that I was not intended immediately to leave.

I sat down then and rested with my back against the overturned boat. All around me the stillness intensified and the wandering tendrils of the fog continued their search. Nothing escaped them.

The broken cup of a wild bird's egg was touched tentatively, as if with meaning, for the first time. I saw a sand-colored ghost crab, hitherto hidden and immobile, begin to sidle amidst the beach grass as though im bued suddenly with a will derived ultimately from the fog. A gull passed high overhead, but its cry took on the plaint of something other than it self.

I began dimly to remember a primitive dialogue as to whether God is a mist or merely a mist maker Since a great deal of my thought has been spent amidst such early human and, to my mind, not out worn speculations, the idea did not seem particularly irrational or blasphemous. How else would so great a being, assuming his existence, be able thoroughly to investigate his world, or, perhaps, merely a world that he had come upon, than as he was now proceeding to do?

I closed my eyes and let the tiny diffused droplets of the fog gently palpate my face. At the same time by some unexplained affinity, I felt my mind drawn inland, to pour smoking and gigantic as the fog itself, through the gorges of a neighboring mountain range.

In a little shaft of falling light my consciousness swirled dimly over the tombstones of a fallen cemetery Something within me touched half obliterated names and dates before sliding imperceptibly onward toward an errand in the city. That errand whatever its purpose, perhaps because I was mercifully guided away from the future, was denied me.

As suddenly as I had been dispersed I found myself back among the boat timbers and the broken shell of something that had not achieved existence. "I am the thing that lives in the midst of the bones"—a line from the dead poet Charles Williams persisted obstinately in my head. It was true. I was merely condensed from that greater fog to a smaller congelation of droplets. Vague and smoky wisplets of thought were my extensions.

From a rack of bone no more substantial than the broken boat ribs on the beach, I was moving like that larger, all-investigating fog through the doorways of the past. Somewhere far away in an inland city the fog was transformed into a blizzard. Nineteen twenty-nine was a meaningless date that whipped by upon a flying newspaper. The blizzard was beating upon a great gate marked St. Elizabeth's. I was no longer the blizzard. I was hurrying, a small

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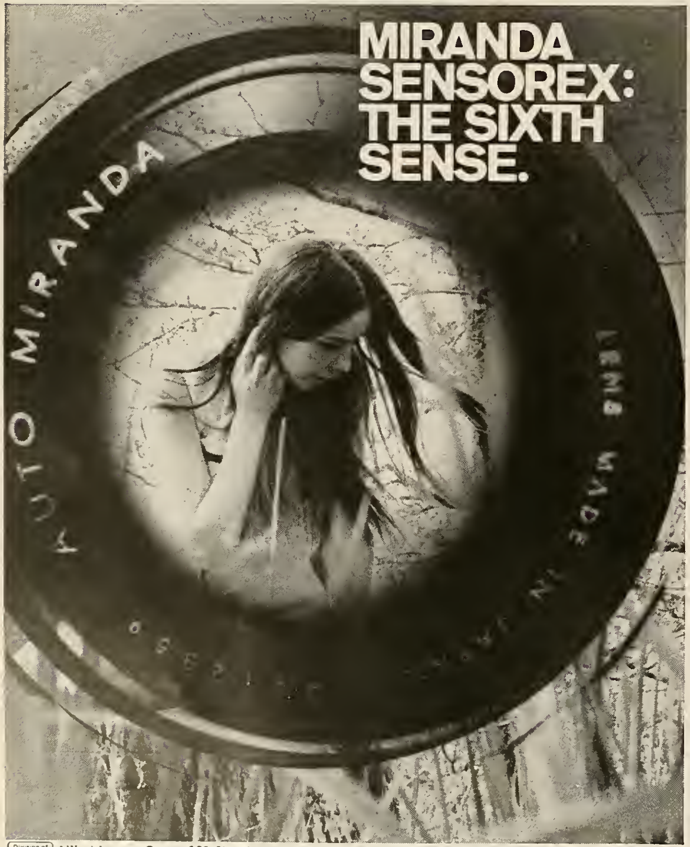
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dark shadow, up a stairway beyond which came a labored and importunate breathing.

The man lay back among the pillows, wracked, yellow, and cadaverous. Though I was his son he knew me only as one lamp is briefly lit from another in the windy night. He was beyond speech, but a question was there, occupying the dying mind, excluding the living, something before which all remaining thought had to be mustered. At the time I was too young to understand. Only now could the hurrying shadow drawn from the wrecked boat interpret and relive the question. The starving figure on the bed was held back from death only by a magnificent heart that would not die.

I, the insubstantial substance of memory, the dispersed droplets of the ranging fog, saw the man lift his hands for the last time. Strangely, in all that ravished body, they alone had remained unchanged. They were strong hands, the hands of a craftsman who had played many roles in his life: actor, laborer, professional runner. They were the hands of a man, indirectly of all men, for such had been the nature of his life. Now, in a last lucid moment, he had lifted them up and, curiously, as though they belonged to another being, he had turned and flexed them, gazed upon them unbelievingly, and dropped them once more.

He, too, the shadow, the mist in the gaping bones, had seen these seemingly untouched deathless instruments rally as though with one last purpose before the demanding will. And I, also a shadow, come back across forty years, could hear the question at last. "Why are you, my hands, so separate from me at death, yet still to be commanded? Why have you served me, you who are alive and ingeniously clever?" For here he turned and contemplated them with his old superb steadiness. "What has been our partnership, for I, the shadow, am going, yet you of all of me are alive and persist?"

I could have sworn that his last thought was not of himself but of the fate of the instruments. He was outside, he was trying to look into the secret purposes of things, and the hands, the masterful hands, were the only purpose remaining, while he, increasingly without center, was vanishing. It was the hands that con-

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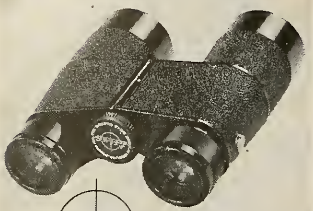

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tained his last conscious act. They had been formidable in life. In death they had become strangers who had denied their master's last question.

Suddenly I was back under the overhang of the foundered boat. I had sat there stiff with cold for many hours. I was no longer the extension of a blizzard beating against immovable gates. The year of the locusts was done. It was, instead, the year of the mist maker that some obscure Macusi witch doctor had chosen to call God. But the mist maker had gone over the long-abandoned beach, touching for his inscrutable purposes only the broken shell of the nonexistent, only the tracks of a wayward fox, only a man who, serving the mist maker, could be made to stream wispily through the interstices of time.

I was a biologist, but I chose not to examine my hands. The fog and the night were lifting. I had been far away for hours. Crouched in my heavy sheepskin I waited without thought as the witch doctor might have waited for the morning dispersion of his god. Finally, the dawn began to touch the sea, and then the worn timbers of the hulk beside which I sheltered reddened a little. It was then I began to glimpse the world from a different perspective.

I had watched for nights the great bolts leaping across the pane of an attic window, the bolts Emerson had dreamed in the first scientific days might be the force that hurled reptile into mammal. I had watched at midnight the mad scientists intent upon their own creation. But in the end, those fantastic flashes of the lightning had ceased without issue, at least for me. The pane, the inscrutable pane, had darkened at last; the scientists, if scientists they were, had departed, carrying their secret with them. I sighed, remembering. It was then I saw the miracle. I saw it because I was hunched at ground level, smelling rank of fox, and no longer gazing with upright human arrogance upon the things of this world.

I did not realize at first what it was that I looked upon. As my wandering attention centered, I saw nothing but two small projecting ears lit by the morning sun. Beneath them, a small neat face looked shyly up at me. The ears moved at every sound, drank in a gull's cry and the far horn of a ship. They crinkled, I began to realize, only with curiosity; they had not learned to fear. The creature was very young. He was alone in a dread universe. I crept on my knees around the prow and crouched beside him. It was a small fox pup from a den under the timbers who looked up at me. God knows what had become of his brothers and sisters. His parent must not have been home from hunting.

He innocently selected what I think was a chicken bone from an untidy pile of splintered rubbish and shook it at me invitingly. There was a vast and playful humor in his face. "If there was only one fox in the world and I could kill him, I would do." The words of a British poacher in a pub rasped in my ears. I dropped even further and painfully away from human stature. It has been said repeatedly that one can never, try as he will, get around to the front of the universe. Man is destined to see only its far side, to realize nature only in retreat.

Yet here was the thing in the midst of the bones, the wide-eyed, innocent fox inviting me to play, with the innate courtesy of its own forepaws placed appealingly together, along with a mock shake of the head. The universe was swinging in some fantastic fashion around to present its face, and the face was so small that the universe itself was laughing.

It was not a time for human dignity. It was a time only for the careful observance of amenities written behind the stars. Gravely I arranged my forepaws while the puppy whimpered with ill-concealed excitement. I drew the breath of a fox's den into my nostrils. I picked up clumsily a whiter bone and shook it in teeth that had not entirely forgotten their original purpose. Round and round we tumbled for one ecstatic moment. We were the innocent thing in the midst of the bones, born in the egg, born in the den, born in the dark cave with the stone ax close to hand, born at last in human guise to grow coldly remote in the room with the rifle rack upon the wall.

But I had seen my miracle. I had seen the universe as it begins for all things. It was, in reality, a child's universe, a tiny and laughing universe. I rolled the pup on his back and ran, literally ran for the nearest ridge. The sun was half out of the

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sea, and the world was swinging back to normal. The adult foxes would be already trotting home.

A little farther on, I passed one on a ridge who knew well I had no gun, for it swung by quite close, stepping delicately with brush and head held high. Its face was watchful but averted. It did not matter. It was what I had experienced and the fox had experienced, what we had all experienced in adulthood. We passed carefully on our separate ways into the morning, eyes not meeting.

But to me the mist had come, and the mere chance of two lifted sunlit ears at morning. I knew at last why the man on the bed had smiled finally before he dropped his hands. He, too, had worked around to the front of things in his death agony. The hands were playthings and had to be cast aside at last like a little cherished toy. There was a meaning and there was not a meaning, and therein lay the agony.

The meaning was all in the beginning, as though time was awry. It was a little beautiful meaning that did not stay, and the sixty-year-old man on the hospital bed had traveled briefly toward it through the dark at the end of the universe. There was something in the desperate nature of the world that had to be reversed, but he had been too weak to tell me, and the hands had dropped helplessly away.

After forty years I had been just his own age when the fog had come groping for my face. I think I can safely put it down that I had been allowed my miracle. It was very small, as is the way of great things. I had been permitted to correct time's arrow for a space of perhaps five minutes—and that is a boon not granted to all men. If I were to render a report upon this episode, I would say that men must find a way to run the arrow backward. Doubtless it is impossible in the physical world, but in the memory and the will man might achieve the deed if he would try.

For just a moment I had held the universe at bay by the simple expedient of sitting on my haunches before a fox den and tumbling about with a chicken bone. It is the gravest, most meaningful act I shall ever accomplish, but, as Thoreau once remarked of some peculiar errand of his own, there is no use reporting it to the Royal Society.

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A Naturalist at Large

Public Parks and Private Lives

by Ira J. Winn

One of the great self-perpetuating myths, which conservationists and wilderness devotees have turned into fervent and desperate belief, is that people are naturally pronature. It is said that once exposed to the beauty and the grandeur of forest and mountain, desert and wild beach, the human being is somehow, almost mystically, drawn and held by the attraction of nature. In effect, the battle for an expanded and improved national park and forest system rests on just this faith: that masses of people, unlike the governor of a rich western state, will not conclude that having seen one redwood, you have seen them all.

But it is not stretching things to say that built into our culture is a fear, perhaps even a hatred, of nature. This fear is reflected in the intense anxiety shown by supposedly worldly people when faced with the stark silence, isolation, and pristine intensity of a wilderness setting. Still more obvious is the indifference or aversion to natural beauty that, apparently, is becoming a characteristic of urban society.

Not too many years ago, I happened to be teaching in a classroom facing one of the ugliest and, in some respects, one of the most typical streets of Los Angeles. It was (and is) a clutter of billboards, telephone and power lines, garishly painted shops, and dirty buildings, which blended into a grotesque blur. There was not a tree in sight to break the shameless monotony. "Look out that window," I told the class one day. "Do you see anything lacking, something wrong with that scene?" They looked a long time before someone ventured, "Not enough parking places."

Now, seven or eight years and many miles later, the props have changed countless times, but the scene is frighteningly similar. In the interval between California and Brazil, I have silently watched drab concrete replace the narrow strip of earth around the expensive home of a friend who can't stand the bother of grass. I have listened to arguments over the values involved in permitting gas stations to take over almost every other street corner, and I remember well the angry talk-stopping rebuttal, "That's the American way!" I have guided many American tourists through Europe, young people for the most part, and I still remember my desperation one rare, vivid day sailing deep in the Norwegian fiords, as more than two-thirds of a group preferred to go below and sit out the two hours drinking, rather than watch the spectacular scenery unfold.

The final straw was added in Brazil. A young woman, a native of Manhattan now living in Rio de Janeiro, recently returned to the high-rise sprawl that is rapidly reducing Copacabana to an oceanside Hollywood and Vine. She was filled with a tale of horror about the few weeks she had spent in the country with relatives—on Long Island, outside New York. "Can you imagine," she asked, "being so far out in the sticks that one is almost overwhelmed by the silence of the night? It was dreadful." She repeated the last several times. "And in the morning you can't even sleep because of the singing of those stupid birds. Oh, I could hardly wait to get back to Copacabana and hear the traffic."

Perhaps these are overly harsh memories. Certainly, among a people habituated to modern comforts it should come as no surprise that the physical world is often taken for granted or actually viewed as the enemy. The wishful thinking of the nature-lorist is possibly but a carry-over of another time when man's relations to the natural world were more constant and more true. For what should be evident is that people cannot come to identify with nature unless they have grown up with, and become a part of, it. Lacking wilderness oases in the cities, lacking even a backyard tree for a child to climb, urban man is highly unlikely to develop any widespread appreciation of the mysterious beauty of the forest.

Nevertheless, those who struggle for the outdoor life often seem to forget that the battle will be won or lost where the people are. It is not the evergreens or the wildlife that writes letters, sends congressmen to Washington, forms citizens' committees, plans land use, or sells real estate. Nor for that matter is it even the scattered minority still caught up in small-town life who will cast the deciding vote on the future shape of the environment. It is city people with city-bred ideas who will determine the degree and direction of environmental change and control. They will do it by force of numbers and by the power of the bulldozer, if by nothing else.

Given the population explosion, the speed of modern transportation, and the conglomerate power of impersonal commercial interests, the contemporary conservation battle is only now taking form. It has been hard enough to awaken people to go along with campaigns for park reserves in isolated regions, but it will be infinitely more difficult to get them to stand up against familiar and closely interlocked groups that bring the struggle home to their own city and pocketbook. Thus conservationists must become even more politically active or they will find themselves politically neutralized and recreationally passé. The struggle for protection of the wilderness, for expansion of those great retreats known as the national parks, cannot be separated from the larger contest, now only beginning, over the way of life in our cities. The campaign for wilderness and the quest for privacy are intimately tied to the search for human dignity, which peaks and erupts in every metropolis.

For the most part the cities are creating citizens who are growingly

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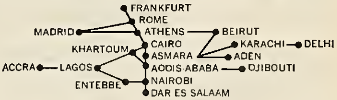

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alienated, both from each other and from the natural world. Nature in our modern American cities, cut off from its organic relation to people and to structures, has become merely decorative. Here a vine is put in to help cover another architectural mistake; there some trees are left to shade a sidewalk or as a vestigial break between property lines. But nature as the grand intermediary between man and his work is almost nowhere to be found. At the same time, urban man is faced with a marked diminution in the use of nature as a retreat from the press of the commercial world, and a startling intensification in nervous stimulation from the constant barrage of voices, signals, and raw information. In time this incessant stimulation becomes self-justifying and outwardly self-fulfilling, and he feels nervous and alone if left without his familiar turmoil. As first noted by the German sociologist Georg Simmel at the turn of the century, this phenomenon of metropolitan life forces man constantly to shout and boldly to exaggerate himself simply to remain perceptible—even to himself. Discrimination becomes blunted as the individual develops a protective shield, and communication between people decreases as the means of communication increase. Thereby reduced all the more to a mere unit of consumption in a mass market, the individual loses the significance of his freedom as he becomes increasingly unable to differentiate between things of value and, simply, "things."

Rather than being used as the spiritual refuge they were intended to be, what wooded preserves are left in the large cities have commonly fallen into disuse and misuse; some have even been allowed to decay into virtual lairs for the twisted products of urban pressures. And whatever works toward rationalizing "civilized" encroachments on woodland preserves in the cities, in turn contributes to the alienation and frenzied emptiness that has become a way of city life.

What is needed is a functional recreation philosophy for our time, one that can deal with the malaise that results from environmental imbalance in our cities. There are several places to begin, and first among them is the long overdue reform in the recreation curriculum of

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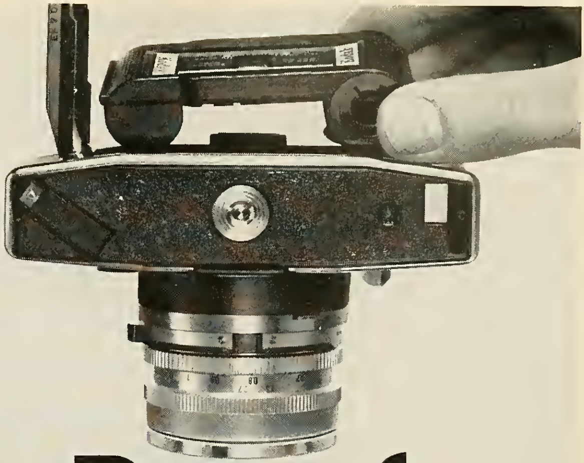
city schools. Often the urban youngster's only intense contact with recreation is through the hopelessly unrealistic curriculum of competitive sports, which stimulates a hunger for nervous excitation and also implants a long-range tendency toward physical passivity. Contrary to popular opinion and coaches' propaganda, youthful experience on the playing fields does not lead to the active life. Instead, the physical potential of a few youngsters is exploited by the coach, the school, and the community, while the majority are conditioned to the spectator state so lucrative to organized sports-business and a fractional minority of big-name players. For most people the active life somehow never proceeds much beyond settling into an armchair—an indulgence in rear-end muscle flexing while absorbed in the frenzied tallying of scores by 10, 18, or 22 young men.

Physical educators should work to instill functional health and exercise habits in all young people, regardless of ability. But in their desperate search for personal glory and some kind of proof of manhood through the winning team, teachers of physical education appear to forget this goal. The emphasis on the winning team and its corollary, spectator sports, contributes greatly to the life pattern that alternates between hypertension and boredom. Life becomes a never-ending search for thrills and distractions. By the age of 25 or 30, the product of this curriculum is fleshy and dull, a physical creep whose greatest athletic effort is caught in the familiar jibe about pushing oneself away from the table. No amount of rationalizing by persons outraged at any criticism of the sacred cows of popularized recreation can negate the terrible truth of a nation addicted to spectatorism and afflicted by a high incidence of heart disease, tension, and obesity. Americans, observed H. L. Mencken, will go anywhere—sitting down.

The schools must effectively begin to teach lifetime health habits combining physical exercise and quiet, studied mental relaxation and contemplation. The stress must shift to the learning of rhythm skills, relaxation and rejuvenation routines, and individualized developmental and corrective motor-muscular and cardiovascular exercises that have



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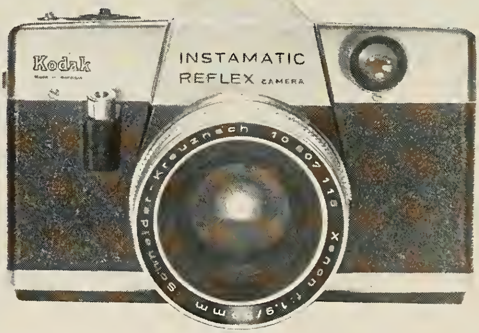

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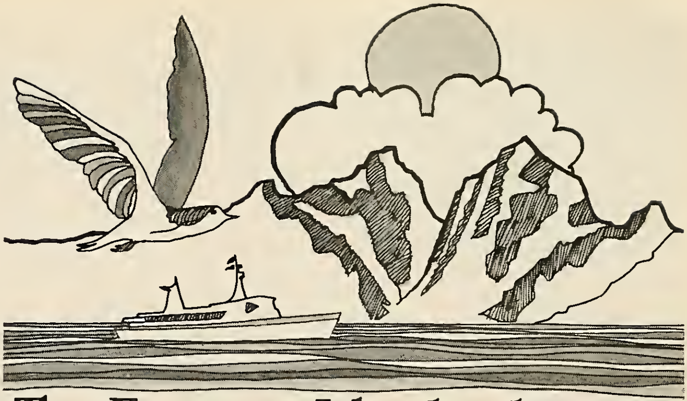
great carry-over value to later life. But the disciplines of yoga and sauna, wilderness hiking and camping, eurythmics, synchronized swimming, cross-country skiing, jogging, and bicycling, for example, should not be taught merely as skills or as a means to social status through the medium of rivalry or self-assertion. For these key arts are the best means of sublimating aggression and learning to appreciate the harmonies of nature by feeling the vitality and joy of rhythmic body movement and physical conditioning for its own sake. Taught as a way of life, rather than as children's games, they form a path to lifelong bodily vigor and sensitivity to the mystery of growth. They open the young mind to love of natural beauty and contentment in beautiful and tranquil surroundings, to mastery of the loneliness of contemplation and disciplined individual expression, and awareness of one's own physical being, secure in self-challenge and respectful amidst the awesome power of nature.

Revitalization of the recreation curriculum involves not just a simple change in the sports orientation of the schools, but demands a much more meaningful relation between the theory of good health and the expected behavior of young people and adults. The needed curriculum requires closing the gap between physical education and biology, with especially strong attention to the lessons of ecology. A successful effort at change therefore implies a basic concern with those key balances required of man if he is to live in tune with nature and at peace with himself and his neighbors. The more natural call for tranquility, harmony, and privacy should replace the hunger for game thrills and nervous stimulation.

American educators would do well to restudy the lessons of *Walden*, the better to learn that the lives of men need not be overflowing with either quiet or noisy desperation. Also, from the perspective of an older civilization seeking a way to technological development without sacrificing its cultural traditions and values, they could profit from the wisdom of its new educational creed. The Ethiopian plan of 1963 defines a key goal of secondary education as the necessity "to develop inner resources of the spirit so that one need not depend all the time on the titillation of the senses from the outside." How unlikely that a statement of that kind would find its way into the declared objectives of an American curriculum.

But schools do not exist in a vacuum, and to become wholly functional even the best of curricula will require a complementary change in the physical community environment. A realistic green-space factor for urban land use—one that puts an end to the modern chicken-coop types of concentrated habitation—must be integrated into law and strictly enforced. The real estate interests, which have so splintered our cities and dehumanized urban living in their lust for the quick sell and the split parcel, will have to be fought and brought under control. Perhaps this can best be accomplished through a system of urban-devlopment grants involving combined federal-state action. But in any case the battle to save the cities can be won only if the citizenry finds wise and spirited leadership dedicated to the concept of urban planning and balanced land use. In effect, natural beauty must be programmed into the urban environment. This means that parks truly must be parks, for in the contemporary idiom parks and playgrounds have been made synonymous; it has become nearly impossible to plan for green space without a golf course or other highly competitive game device to monopolize the area. Thus high-density, residential sections of the city must be particularly well planned for an abundance (not merely an "adequacy") of air and sunlight and for the recreation and rehabilitation value that woodland green space offers to clustered human beings.

Frank Lloyd Wright once claimed hat he could remake the jumble that is New York and, on the very same area, build from the ground up a new and more populous skyscraper city set amidst parks and gardens. The challenge need not be a visionary dream, for the task of urban reconstruction must begin with a willingness to face the magnitude of the problem and to depart from traditional forms and dependency on patchwork solutions. Twenty or more entirely new, planned cities of about 500,000 persons each are needed in the immediate future to ease



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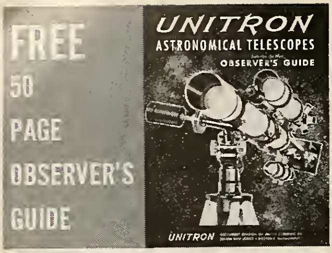

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the problems of existing cities while also opening possibilities for the best green space development and reconstruction. This is not as impossible a task as it may at first sound, especially as various examples of new-city and town planning already exist. Further, the long-run costs are small compared to those of the present deficit-ridden cities with their impossible burdens of urban sprawl, pollution, blight, overcrowding, and haphazard localization.

Given the scope of modern construction techniques and the mobility that has come with modern transportation, city growth need not be limited to present sites, which commonly developed as a function of the needs of the old western frontier. Today entirely new urban sites can be chosen, using esthetics among the most basic considerations. In the light of past experience, balanced urban land use suggests fixed minimum lot size and minimum green spacing for homes and apartment buildings as an integral part of the incorporation charter of a city. The guarantee would be reinforced by setting aside large belts of parkland to be known as Greenbelt National Parks running through and around the urban areas. These would be made eternally inviolate from all the rapacious interests that to date have managed to pressure and control city and country administrations and thus frustrate sound urban growth.

In other words, the nationally protected park system that for so long has been thought of in terms of an "outback" must be brought home where the people are. Initially, this will be much easier to plan and implement with respect to new cities, but the concept of urban national parks can be applied equally well to the old. For as the old cities (the present ones) lose population to the carefully planned advantages and attractions of the new, greater opportunities will open up for complete reconstruction and rezoning, including land acquisition for the greenbelts by the National Park Service or a new National Urban Woodlands Commission. However much the cities might then tend to grow toward each other or even blend, the protected greenbelts—and what they imply for people's learned desires for living—will work to prevent the kind of urban bog that is virtually taken for granted in the cities of today.

Out of a balanced urban environment can spring a new kind of urbanite, one who has developed the need for intimacy with nature and who has the capacity to enjoy equally the restless searching, the verve and hurly-burly of city life, and the tranquility that can be gained from country atmosphere. A number of mutually reinforcing and amplifying changes in the very style of life would inevitably begin to occur as a function of successful reform of the recreation curriculum and reconstruction of the physical environment. For one thing, active involvement with the natural environment would stimulate new interests and a marked decline in passive recreation. And as the utter starkness of the city environment was broken, relations between people would become softer and more open.

It is true that the numbers of people coming to the wilderness parks would jump, but the kind of visitors would reflect the healthiness of the change in philosophy: fewer gawkers, screamers, and litter throwers, and many more people seeking intimacy with nature and rejuvenation of body and spirit in primitive surroundings. Indeed, the great national parks, which already are threatened or beset with commercialization and overcrowding, should be emptied of virtually all permanent settlement and all the distracting intrusions of resortism. As is already planned in part for the Yosemite Valley, modest facilities would be located in discrete clusters near, but outside, the park peripheries, with trailer-camp visitors and passing tourists bused in and out each day. Thus, public policy would reinforce the general direction of the new recreation movement by preserving the parks as refuges for modern man.

Hope for man's future begins in good part with man's longing for nature—a spirit that is too dear a heritage to be left to wither and die out in the concrete emptiness of the modern megalopolis. Not only does the beauty without reflect what man really values and cherishes, but the shape of the environment greatly affects the life forces within. In this sense the larger struggle for the national parks is both crucial and symbolic. It is a measure of modern man.

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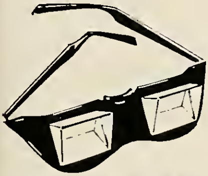

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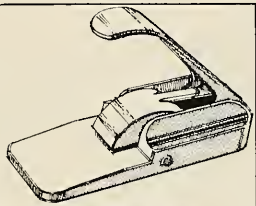

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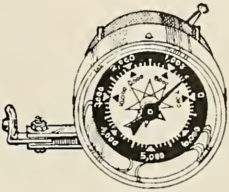

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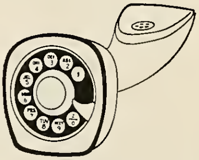

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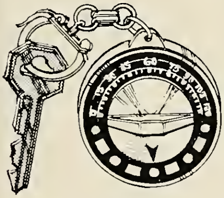

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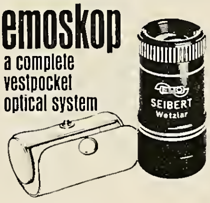

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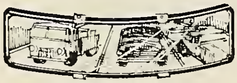

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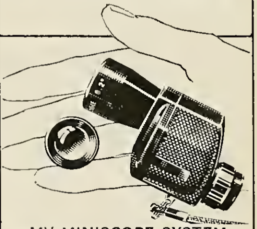

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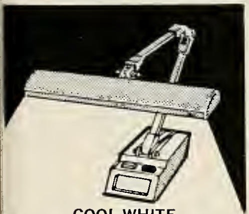

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Jumping Spiders

In recent years the habits of predatory animals have had the benefit of what public relations people call "good press." Such wide-ranging coverage—in journals, in magazines, and in newspapers—has made us increasingly appreciative of the ecological role and value of these dramatic, picturesque animals, particularly of the larger forms such as the cats, wolves, and birds of prey. No less deserving of some favorable publicity are some of the lesser-known predators, among them certain spiders. These spiders are predators par excellence, "tigers" in miniature, hunters every bit as skilled as the eagle or the leopard. Distributed worldwide, the family I have in mind is represented by hundreds of species. Some are bright green, others iridescent gold or purple, and one species—like the American flag—is red, white, and blue.

There are, of course, many different kinds of spiders, and each group is distinguished by peculiarities of structure and habit. The web-weavers are often richly colored, and are universally admired as consummate architects. Crab spiders, wolf spiders, and fishing spiders are a few others whose names suggest their singular and intriguing behavior. Rightly famous, too, is the secretive trapdoor spider, living just beneath the surface of the ground in silk-lined tunnels from which it emerges at night to await the passing of nocturnal wanderers. When an insect strays close by, the spider grabs it, hauls it back into its antechamber, shuts the trapdoor behind, and proceeds to have a meal.

Other types of spiders also attract popular attention occasionally, but among the vast zoological order of Araneae, which includes more than 50,000 species, the family that usually arouses the greatest interest on the part of spider enthusiasts is the one known as the Salticidae—the jumpers. These are among the smallest of spiders, ranging from about one-tenth to seven-tenths of an inch in body length, depending upon age and species. Because of their diminutive size, and because they do not spin webs, they are inconspicuous. However, if we look around carefully, we can find these hunters almost everywhere: on the ground; on rocks, trees, and plants; even running up the windowpanes of houses. There are, of course, greater numbers and varieties of them in the tropical parts of the world, but hardly a place on the solid earth does not serve as home for at least one or two species.

Many of us assume that all spiders spin webs, and that a web is the only means a spider has of capturing edible insects, but there are several huge families of spiders whose members do not make webs. Among these the jumping spiders, like wolf and crab spiders, are categorically referred to as "hunters." But each hunting type has developed unique living habits.

Almost all spiders other than the salticids, if not virtually blind, are myopic and consequently must play a more or less passive role in the acquisition of food. A web-weaver, for example, might have to wait for days before an insect becomes trapped in its snare. Other spiders must also wait patiently until their prey wanders close, or even bumps

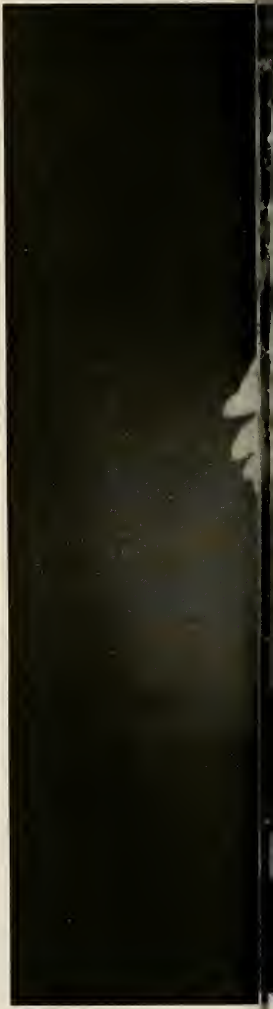
by James H. Carmichael, Jr.

viewing: Unlike
spiders, the diminu-
alticids have splen-
ision, valuable for
ng prey. Largest of
ight eyes, in the
at left, is the fron-
ir.

eaping: Salticids
d on good vision,
legs, "sticky" feet
n acrobat's preci-
f the tiny spider at
misses the leaf tip,
ken dragline will
ort its dangling
t.

Left: This predator at dinner is native to the tropics. Its digestive juices, injected into the prey, turn tissue into liquid food.

Right: A jump that has failed, but no harm to the spider. When it leaped from the leaf, its dragline as usual trailed behind. Now it climbs back up the line to starting point.



into them, before they are able to pounce upon and capture it. On the other hand, jumping spiders are active, deliberate hunters whose predatory tactics invariably invite comparison with those of the cat family. Possessed of excellent vision, they spend most of the daylight hours searching diligently for live food, and despite their small size they can clearly detect moving insects from distances up to thirty times their own body lengths. Once having sighted their prey, they stalk and subdue it in a fashion that would put our most accomplished housecats to shame. We shall see presently how this is done.

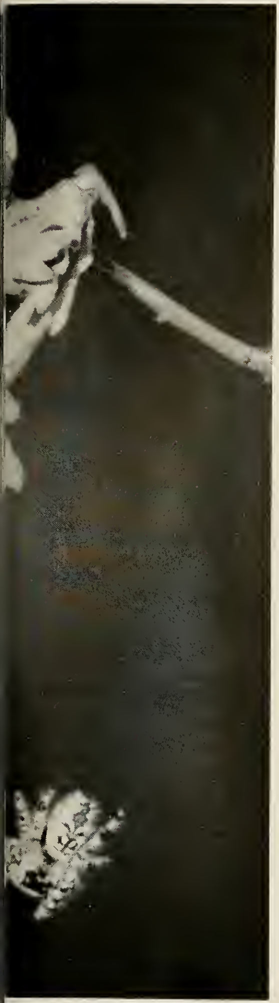
Jumping spiders are so named because of their singular manner of locomotion, and by this characteristic alone an experienced observer can distinguish them at a glance from all other types. Their movements are spasmodic—a brief run, a sudden stop, a slight movement of the head, and then a slow crawl; another stop, a few wiggles of the abdomen, a tense crouch, and then a quick little jump. If a salticid is alarmed by some threat to itself or if it is in rapid pursuit of a moving prey, it does not run along evenly like a wolf spider. Instead, it advances by a series of jumps, each executed with agility and accuracy. True, we might see other kinds of spiders jump occasionally, but they do so more clumsily and generally only in response to being suddenly startled.

For their size, jumping spiders are capable of leaping prodigious distances. Although an average jump seldom exceeds two or three inches, most salticids can, if the occasion demands, leap a span of seven or eight inches (on the human scale, such a feat would be equivalent to a standing jump of thirty or forty feet). This may not seem particularly surprising when we consider the jumping prowess of a grasshopper, but the grasshopper has enormous legs in proportion to his body, and it is frequently assisted by its wings. Furthermore, the grasshopper is a fairly reckless jumper; it seems to seldom pick an exact landing place. But the jumping spider selects a definite target—be it an insect or a nearby twig—and judges precisely the propulsion required to traverse the distance to it.

Although these remarkable little animals generally use all eight of their legs for walking or running, only the two hind pairs are used for jumping. Oddly enough, the rear legs are generally smaller and less muscular than the front ones. It seems that the front legs are better developed for that most vital of spider activities—grappling with a violently struggling victim.

Unlike many other spiders, the salticids have peculiar tufts of adhesive hairs on the bottom of their feet, which enable them to walk upon highly polished surfaces—in and out of bathtubs, for example, and even upside down on glass. This feature gives them excellent purchase whe jumping, and they can jump a curately from either slick or roug textured surfaces. The adhesive hai also allow the spider to "stick" in mediately to the spot where it land even if this is on a vertical surfa or the underside of an object.

Strong legs, "sticky" feet, s perior vision, and excellent coord nation combine to make the jumpir spider a precise acrobat. Only rare does it fail to land upon the spot f which it is springing. If it shou



miss a precarious target—such as the ip of a distant leaf—it might begin umbling toward the ground. But we notice that it falls only a short distance, then comes to a sudden stop n midair, suspended at the end of a hin silk line that it anchored careully at the takeoff point before jumpng. It then clambers up this safety ine to attempt another leap.

The spider trails this silk "dragine" behind him at all times. When preparing to jump, the animal merely touches its spinnerets (the silk-releasing tubes at the rear of the abdomen) firmly on the takeoff surface in order to fasten the line securely. The line is so delicate that it in no way interferes with the jump, but it is strong enough to "catch" the spider and support its entire weight in case it misses the mark. In fact, a jumping spider may sometimes be found dangling in midair at the end of this nearly invisible line while still fighting to subdue an insect whose struggling has just toppled them both into space. Having killed its victim, the spider may then simply remain suspended, swinging to and fro as it holds and eats its meal.

Unique in their habit of jumping from spot to spot, the salticids are also noted for their excellent vision. A few wolf spiders possess fairly good eyesight, but compare poorly with the salticids, whose vision is not only the keenest by far of all the spiders but seems relatively better than that of many vertebrate animals. As Dr. Willis Gertsch states in his book *American Spiders*:

"Quite friendly little creatures, they sometimes sit upon a finger and follow one's every move with an attention not ordinarily manifest in arthropods bound by complex instinctive patterns. Fine eyesight has made them the outstanding spider extroverts."

Like most other spiders, the salticids possess eight simple eyes, but these are spaced in such a manner that two small pairs are on the back of the head (cephalothorax), allowing the animals to detect movements above themselves and somewhat to the rear. Another pair of small eyes looks forward and, in some species, slightly outward toward the sides. Two of their eight eyes, however, are larger and obviously more efficient than the others. These two are situated side by side on the front of the head, and give the face a curiously human look. This frontal juxtaposition of the two principal orbs, and the remarkable accuracy with which they judge distances, leads one to suspect that the small animals possess a keen form of stereoscopic vision.

Like most other predators, jumping spiders generally detect their prey by its movements; but I have often been amazed by their ability to recognize live insects that seemed to be sitting perfectly motionless. Yet salticids seldom stalk dead insects. This indeed would seem to point to a highly developed sense of visual discernment.

Since the jumping spider does not use a web to ensnare its victims, it must rely upon its strength, stealth, eyesight, and fangs to secure food. Thus equipped, it is the nemesis of flies, mosquitoes, and many other insects. It is quite fastidious about the freshness of its food and seldom eats an insect that it has not killed. Its normal hunting procedure is to prowl slowly and attentively, but it may simply wait motionless in a favored spot. Upon sighting a distant morsel, it immediately assumes a catlike crouch and begins advancing cautiously toward the prey, frequently taking advantage of cover. Closer and closer it creeps, sometimes to within an inch of its victim. When near enough to jump, it often pauses a moment and uses its pedipalps (a pair of flexible "foot-feelers" at the front of its head) to wipe its eyes and fangs clean, as if determined not to lose a meal by some oversight. With its powerful front legs extended fully, it suddenly springs and grabs the prey in a furious flurry of wings, legs, and torsos. The little spider holds on to the insect tenaciously while sinking its fangs into the victim's body. After a few moments all movement subsides; the venom takes effect quickly. Digestive juices are then pumped into the insect's body to dissolve its tissues, which the spider can ingest only in liquid form.

Although jumping spiders may hunt and kill as many as six or eight insects in a day, they can also survive surprisingly long periods without food. By mistake I once kept some specimens in corked bottles for six weeks without feeding them, and although their abdomens withered to almost nothing, they survived and thereafter continued to lead a normal existence.

As a family, the salticids have adapted themselves to a variety of climatic conditions. They thrive in the moist tropics, but have also been found in deserts and even as high as 22,000 feet on Mount Everest, an elevation at which very few other animals live. Furthermore, they can endure sudden changes of altitude and temperature without noticeable harm—the same changes would kill many other invertebrates. In Mexico I once transported about twenty individuals of different species from the steaming sea-level tropics of Vera Cruz to a chilly 11,000 feet, where they behaved as vivaciously as they had in their original habitat. On the entire trip, which took several hours, they were kept in tightly corked bottles into which only a minimum of air could enter. These twenty fulfilled their normal life expectancies at a high altitude, seeming not to have suffered in the least from such a radical change of environment.

The average jumping spider does not, however, spend all its hours in search of edibles or traveling from the tropics to the mountains with collectors. It devotes a good part of its life, as do we, to the pursuit of a mate, and this aspect of its existence is filled with considerable color and excitement.

Upon encountering a female at mating time, the male at once initiates a flamboyant courtship. His first concern is to convince the female that he is not just another item to be grabbed and gobbled up, so he begins by waving his front legs at her, presumably a signal to his prospective mate to hold off her attack. He approaches uneasily, for the female is larger and could readily subdue him if she were motivated by hunger alone. The males of each species practice their own refinements of courtship (one even rolls his eyes), but common to all is a demonstration of dancing, swaying, reeling, or gesturing in front of the female prior to the act of mating. These movements apparently lull even further her tendency to attack a smaller, edible-looking creature.

The performance by the male may last for as much as an hour. Nature has provided the male with an additional aid to courtship. On his face, his palps, his jaws, or his legs, he wears an array of colorful hairs, often iridescent, which he displays before the female, exhibiting them to best advantage when he gesticulates with his frontal appendages. Generally, as though hypnotized by his vigorous gestures, the female responds by making similar movements. Finally she embraces him; he reciprocates, and off they "dance" in a mad whirl.

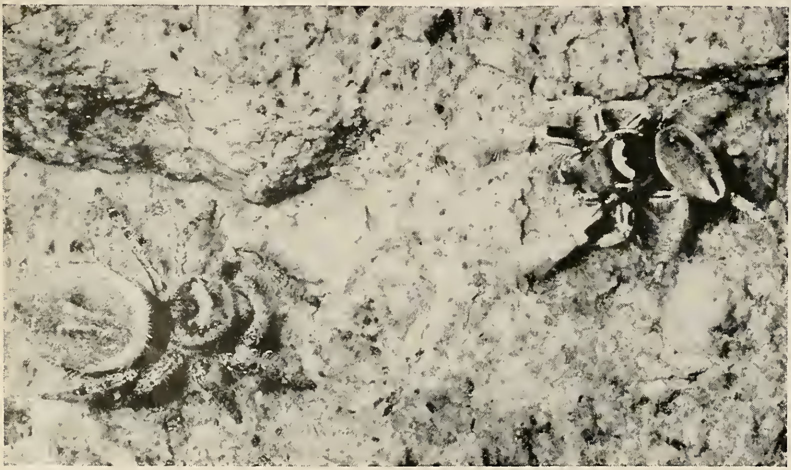
The mating act takes place when the tense excitement of courtship has subsided. The male must insert the tips of his palps, which are swollen with sperm, into two small openings on the underside of the female's abdomen. This exposes him once again to the danger of being grabbed and eaten by the female; but, although some females of other spider families kill and eat the male after mating, jumping spiders almost always separate peacefully.

As we have seen, the salticids manufacture a dragline, which they constantly trail behind them. They also employ their silk to construct small, tightly woven "cocoons" in which to pass the night, to molt, and to hibernate. These they attach beneath the leaves or loose bark of trees, in the crevices of rocks, or in other protected places. Frequently a male and female inhabit one of these snug retreats together, and it is within this silk encasement that the female deposits her eggs. The females of some species lay as few as five eggs, while others lay more than a hundred, usually maintaining close guard over the eggs until the spiderlings have hatched.

The young spiders hatch from the eggs as miniatures of their parents, and unless disturbed, they remain in their silk "nursery" for several weeks (sometimes much longer) before venturing out into the world. When the spiderlings finally set forth, they are quite capable of fending for themselves, stalking and capturing small prey in the same manner as their elders.

Soon after leaving the nursery,

Text continued on page 68



Perils of courtship: In
photo at left the male
right, flips his tail an
shakes his forelegs as h
approaches; the lullin
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from attacking him. Mat
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Closer look: In blowup i
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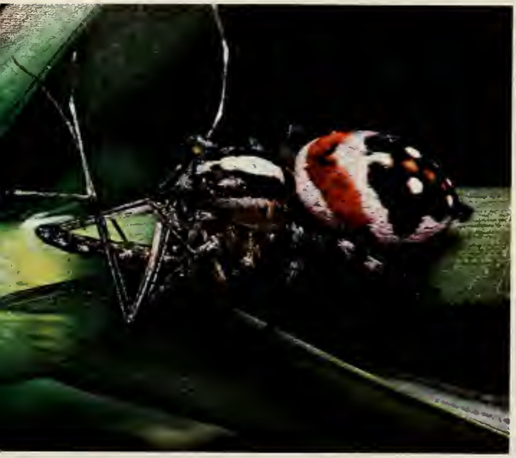
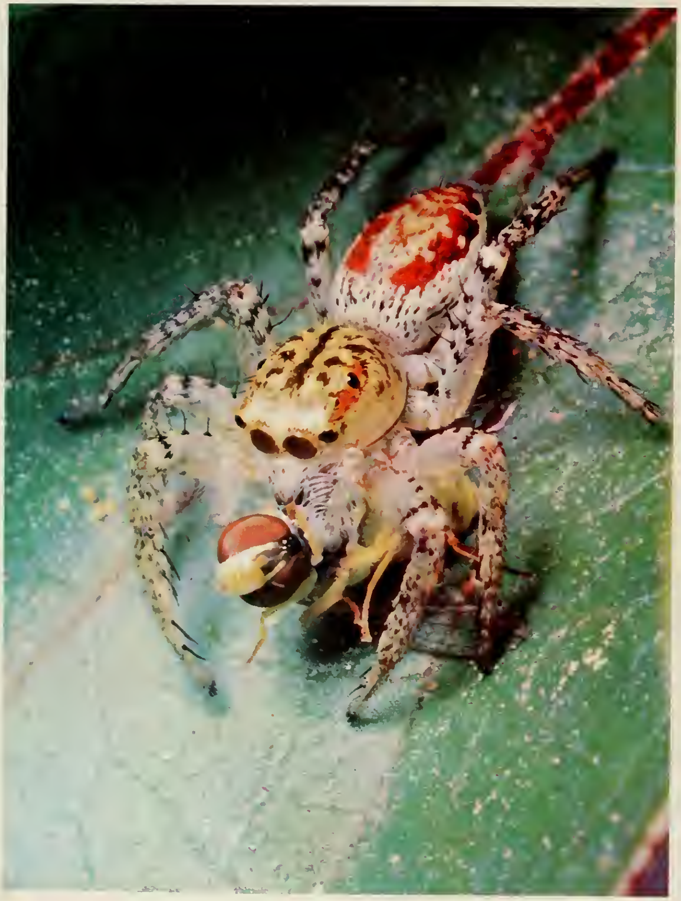


In each of these three photos, a jumping spider is eating an insect. At left, a mosquito is the prey; coloration of the spider (from Mexico) suggests the American flag. The spider below and the one at right (its vivid colors are typical of specimens from the tropics) are each eating a fly. Because they are small and very active, they are best photographed when caught at dinner.



Landscape Esthetics

How to quantify the scenics of a river valley

by Luna B. Leopold

This infrared photo—taken from a jet aircraft at 35,000 feet—shows a stretch of Hell's Canyon, formed by the Snake River on the Idaho/Oregon border. In this area, the river is unusually straight in a north-south direction, providing a streamside viewer with distant vistas, looking upstream or down through the canyon. Red-tinted areas are vegetation and white areas on nearby mountains are snow. (North is top of photo.)

There are an increasing number of bills before Congress that in one way or another affect the landscape or the environment. Each of these requires seemingly endless numbers of congressional hearings, which are recorded upon endless reams of paper.

And if, for some reason, you happen to read the voluminous testimony surrounding one of these environment-affecting proposals, you will generally find a marked contrast between the volume and kind of information presented by those who are pressing for technical development—building a dam, constructing a highway, installing a nuclear power plant—and the testimony of those who either oppose the development or wish to alter it in some way. The developer usually employs numerical arguments, which tend to show that there is an economic benefit to be obtained by constructing something—whatever that something may be. The argument is usually expressed in terms of a "cost-benefit ratio." It is typically argued, for instance, that the construction cost of a given project will be repaid over a period of time and will yield a profit or a benefit in excess of the development costs by a ratio of, let us say, 1.2 to 1. The argument is further supported with great numbers of charts, graphs, tables, and additional figures.

In marked contrast, those who favor protection of the environment against development are fewer in number, their statements are based on emotion or personal feelings, and they usually lack numerical information, quantitative data, and detailed computations. Perhaps this is the reason why this latter group seems to be continually fighting rear-guard actions—losing battle after battle.

The time has come when the argument of the environmentalist might best be presented by (1) separating facts from emotions in relation to the environment, and (2) by providing him with a means of quantifying his arguments: using numbers to talk about the landscape. While to some of us this may be a little like using a computer to describe Shakespeare, it seems that society still has the right to have all aspects of any proposed development presented in a way that is as objective as possible.

One strategy used by environmentalists or conservationists to combat this paucity of statistical barter involves an attempt to describe society's interest in landscape integrity in monetary terms, which make a region's esthetic attributes appear to be similar to the kinds of benefits ascribed to the planned development. From this has arisen the unfortunate and unsound procedure of evaluating recreation in terms of what is called the "visitor day." This argument is based on the idea that the average visitor to a particular place spends one dollar a day (or some other amount) there, which he would not have spent had he not visited the spot, and that the enjoyment derived therefrom is in direct proportion to the amount of time or money spent in the given area. To me, this procedure misses the whole point of recreational activity since we know, by experience, that recreational enjoyment is by no means dependent upon either of these factors. Rather, it appears more sound to develop a way of directly describing the quality of the recreational experience. A first step toward this goal is to objectively describe the landscape itself, which the recreationist visits for enjoyment without regard to expenditure of money or time.

Toward this end, in August, 1968, I began a study designed to produce a method that would quantify the esthetic features of the environment so that the resultant data could be used in many planning and decision-making contexts. Such data could be especially useful when choices must be made among alternative courses of action. They would tend to provide a more prominent consideration of nonmonetary values to society.

The event that gave rise to this report was the application made several years ago to the Federal Power Commission for license to construct a hydropower dam in the Hell's Canyon area of the Snake River in Idaho. Three dams are already operative in the upper parts of Hell's Canyon, but there is still about a hundred miles of undammed river that retains a special character because it is not easily accessible. The river in this section flows through a deep, narrow gorge whose rocks and vegetation give it a particular grandeur. Proposals for damming of the Snake have been vigorously opposed by the country's leading conservation organizations. In the ensuing controversy over this issue, the following alternatives have been proposed: to dam another, nearby river instead of the Snake, to change the size and location of the proposed dam, to abandon the dam proposals altogether, and so on—the usual gamut of moves and countermoves.

The problem posed, then, was to determine objectively if (and in what sense) Hell's Canyon is indeed esthetically unique. The answer to this question would hopefully guide the decision as to whether the river should be dammed in this area. The study thus undertook to evaluate the factors influencing the esthetic appeal of Hell's Canyon. Toward this end, a comparison was made between Hell's Canyon and other river valleys in central Idaho. Then another comparison was made between Hell's Canyon and several well-known valleys in presently established national parks.

Three types of factors appear relevant to landscape esthetics. These groupings of factors and their "subfactors" are listed in table 1. The first group involves the physical features of an area—the presence of mountains and valleys, width of valleys, height and type of mountains. The second group includes those features that have to do with the region's biology, especially—in the case of river valleys such as Hell's Canyon—the vegetation near the stream and on the mountainsides, and the biology within the water itself. A third class encompasses what I have called "human interest factors." These are often more intangible than either the physical or the biological ones, but they are nevertheless influential in determining how the landscape impresses us. For example, if one is at the point on the Delaware River where George Washington is supposed to have thrown the silver dollar, that historical incident, however apocryphal, gives that place a distinct meaning. The phrase "Lincoln slept here" is of a similar sort—there is a human interest associated with the sites where certain phenomena exist or where unusual events have occurred.

Another set of circumstances, also related to the human interest factors, is the presence or absence of vistas or scenic outlooks. The many travelers who pull off to the side of the road at a turnout marked "scenic viewpoint" or "scenic outlook," are an indication that the ability to look from some vantage point across great distances, often to mountains or into far valleys, gives the landscape some special character—whether at a mountaintop or in a river bottom.

The question of access also falls within the realm of human interest. In the listing of criteria I have broken accessibility down into two parts: access to the individual, especially the hiker, and separately, mass use, meaning availability to motorized transport.

Human interest is affected by the general level of urbanization; it can make a piece of landscape more interesting or the opposite. The view from the Berkeley hills, for example, across the bay to San Francisco is made attractive by the skyline of San Francisco itself. In this case, the presence of the city seen from afar seems to make the landscape more interesting. On the other hand, in certain kinds of mountain country the presence of a great many cottages along a road may tend to detract from its inherent character, and have the opposite effect.

Within the list of human-interest criteria, I have included the term "misfits." One often remarks on how certain kinds of architecture fit into a particular landscape; probably one of the things that makes the Swiss mountain landscape so appealing, especially to American visitors, is that the type of architecture and the handling of building location seem to fit especially well into the particular environment. On the other hand, if you were to put a flashing neon sign advertising hamburgers on one of the Swiss chalets, it would be a cultural shock, and I would call it a misfit. So, also, in American landscapes one might be enjoying a drive through a rural countryside and suddenly be confronted with a tremendous dump of car bodies or even an obnoxious roadside billboard. These I consider to be misfits: they are out of character with natural surroundings. One does not mind seeing a large neon sign in the city nearly so much as seeing it in the countryside where it seems out of place.

The other two classes of factors are less complicated than the human-interest group. The physical factors are the easiest to measure in the field. Such factors as river width, river depth, and certain other characteristics require only a recording device or an elementary observation of the river channel. Under biological factors the list includes water color, turbidity, amount of algae, and the kind and extent of water plants, which are often indicative of stream purity or pollution. Under the three categories, a total of 46 criteria were chosen to describe a landscape's esthetic character.

After the factors were chosen, twelve river valleys in central Idaho, including Hell's Canyon, were chosen for evaluation sites that would have some potential for power development. Locations with such potential were selected in order to restrict the sites under discussion to those having something in common with Hell's Canyon. Each site was physically evaluated by standing at the edge of the river, thus providing uni-

Table 1: *In this study, the esthetic qualities of sixteen river valleys are described by means of the 46-factor checklist at right—a first step in determining the relative uniqueness of each site.*

FACTOR NUMBER	DESCRIPTIVE CATEGORIES	EVALUATION NUMBERS 1	2	3	4	5
	Physical Factors					
1	River width (ft.) at	<3	3-10	10-30	30-100	>100
2	Depth (ft.) low	<.5	.5-1	1-2	2-5	>5
3	Velocity (ft. per sec.) flow	<.5	.5-1	1-2	3-5	>5
4	Stream depth (ft.)	<1	1-2	2-4	4-8	>8
5	Flow variability	Little variation		Normal	Ephemeral or large variation	
6	River pattern	Torrent	Pool & riffle	Without riffles	Meander	Braided
7	Valley height/width	≦1	2-5	5-10	11-14	≧15
8	Stream bed material	Clay or silt	Sand	Sand & gravel	Gravel	Cobbles or larger
9	Bed slope (ft./ft.)	<.0005	.0005-.001	.001-.005	.005-.01	>.01
10	Drainage area (sq. mi.)	<1	1-10	10-100	100-1000	>1000
11	Stream order	≦2	3	4	5	≧6
12	Erosion of banks	Stable		Slumping		Eroding
13	Sediment deposition in bed	Stable				large-scale deposition
14	Width of valley flat (ft.)	<100	100-300	300-500	500-1000	>1000
	Biologic & Water Quality Factors					
15	Water color	Clear colorless		Green tints		Brown
16	Turbidity (parts per million)	<25	25-150	150-1000	1000-5000	>5000
17	Floating material	None	Vegetation	Foamy	Oily	Variety
18	Water condition (general)	Poor		Good		Excellent
	Algae					
19	Amount	Absent				Infested
20	Type	Green	Blue-green	Diatom	Floating green	None
	Larger plants					
21	Amount	Absent				Infested
22	Kind	None	Unknown rooted	Elodea, duck weed	Water lily	Cattail
23	River fauna	None				Large variety
24	Pollution evidence	None				Evident
	Land flora					
25	Valley	Open	Open w. grass, trees	Brushy	Wooded	Trees and brush
26	Hillside	Open	Open w. grass, trees	Brushy	Wooded	Trees and brush
27	Diversity	Small				Great
28	Condition	Good				Overused
	Human Use & Interest Factors					
	Trash & litter					
29	Metal no. per	<2	2-5	5-10	10-50	>50
30	Paper 100 ft. of	<2	2-5	5-10	10-50	>50
31	Other river	<2	2-5	5-10	10-50	>50
32	Material removable	Easily removed				Difficult removal
33	Artificial controls (dams, etc.)	Free and natural				Controlled
	Accessibility					
34	Individual	Wilderness				Urban or paved access
35	Mass use	Wilderness				Urban or paved access
36	Local scene	Diverse views and scenes				Closed or without diversity
37	Vistas	Vistas of far places				Closed or no vistas
38	View confinement	Open or no obstructions				Closed by hills, cliffs or trees
39	Land use	Wilderness	Grazed	Lumbering	Forest, mixed recreation	Urbanized
40	Utilities	Scene unobstructed by power lines				Scene obstructed by utilities
41	Degree of change	Original				Materially altered
42	Recovery potential	Natural recovery				Natural recovery unlikely
43	Urbanization	No buildings				Many buildings
44	Special views	None				Unusual interest
45	Historic features	None				Many
46	Misfits	None				Many

KEY: < less than, > greater than, ≦ less than or equal to, / divided by

SITE NO.	LOCATION	TOTAL UNIQUENESS RATIO
1	Wood River, 6 miles above Ketchum	11.07
2	Salmon River, ¼ mile above Stanley	11.00
3	Middle Fork Salmon River at Dagger Falls	11.87
4	South Fork Salmon River, near Warm Lake	13.93
5	Hell's Canyon, below Hell's Canyon Dam	16.09
6	Weiser River at Evergreen Forest Camp on Highway 95	11.17
7	Little Salmon River, 6 miles north of New Meadows	23.10
8	Little Salmon River, 4 miles south of Pollock	13.78
9	Salmon River, 2 miles below Riggins	10.25
10	Salmon River, at Carey Falls, 20 miles above Riggins	14.31
11	French Creek, 1 mile above junction with Salmon River	11.95
12	North Fork Payette River, near Smiths Ferry	10.21

Table 2: *"Total uniqueness value" (see text for full explanation) is an objective measure of how different each site is from other sites studied, without regard to "positive" or "negative" esthetic values. River pollution at Site 7, for example, makes this area relatively unusual and gives it the highest "uniqueness ratio."*

formity in the way the observer looked at the environment. One could just as well have chosen evaluation sites that were part way up the valley sides, but this would have had the disadvantage of putting the observer at varying distances from the river.

At each site the checklist of 46 items was filled out. It can be seen from table 1 that most of the physical factors could actually be evaluated with some common unit of measure. Others, however, had to be estimated in terms of categories—erosion of stream banks, for example. In all cases there were five evaluation categories specified in the checklist. During evaluation, each site was described by assigning to each factor a number from 1 to 5, according to its physical, biological, or human interest characteristics. Where physical measurements were involved, the five categories varied in their span in an unbroken progression. For example, the five categories of river width were: less than 3 feet, 3 to 10 feet, 10 to 30 feet, 30 to 100 feet, and more than 100 feet. In this way, the categorization of a given site with regard to one of the factors could always be fitted into the category quantities.

One of the purposes of the study was to eliminate personal subjectivity in landscape analysis. Accordingly, the "evaluation numbers" for each of the 46 factors in the checklist serve a descriptive function only; evaluation number 5, for example, is not to be interpreted as "superior" to evaluation number 1, or vice versa. If a given site has a river width of more than 100 feet, our analysis does not rank this area above one whose river width is, let's say, less than 3 feet, but merely assigns different evaluation numbers to each of these locations.

The results of such a comparative study depend in part on the sites chosen for comparison. This being the case, another set of comparisons was made between Hell's Canyon and a series of rivers in four national parks of the United States. In this way I could find out not only whether Hell's Canyon is very different or rather like other river sites in Idaho, but also how the region compared esthetically with some of the great beauty spots that the nation has already recognized by giving them national park status.

Any scheme for comparing landscapes must rest on some philosophical framework. The philosophy underlying the scheme I used is the following: *Landscape that is unique either in a positive or negative way is of more significance to society than one that is common.* A place of great scenic beauty is of importance because of its scenic qualities. On the other hand, one could imagine a unique site which is extraordinarily unattractive—a large, neglected, pestilential dump, for example. This also has significance for society, but in the opposite sense.

Having obtained the checklist data from 12 river valley sites in the Idaho region, the next step was to compare the sites factor by factor in order to determine the relative uniqueness of each factor at each site. Let us take river width, for example. As mentioned, with regard to this factor each site would be placed in one of five categories. Most of the sites had river widths falling into category 4—somewhere between 30 and 100 feet. A small number had widths greater than 100 feet, and a few fell in category 3, having a width from 10 to 30 feet.

To discover the relative uniqueness of each site's river width, we then determine how many among the 12 sites had river widths falling within each of the 5 categories. If it happened, for example, that there was only one river more than 100 feet wide, no other sites would share the 5 categorization, and this would determine what I call the "uniqueness ratio" of this one river. The uniqueness ratio for the river in question is equivalent to the reciprocal of the number of sites sharing the category value. The number 1, or unity, divided by the number of sites sharing the value, in this case 1, gives a uniqueness ratio for that particular site of 1.0. If there were two sites that shared category 5 in river width, each would be assigned a uniqueness ratio for river width of unity divided by 2, or ½ (.50). If, for a particular factor, all 12 sites fell in the same category, each of the 12 would be assigned a uniqueness ratio of 1 divided by 12, or .08.

By this method, then, each site had a uniqueness ratio for each of the 46 factors that were measured in the field. Adding uniqueness ratios for all 46 factors for a given site yields a "total uniqueness ratio." In this way, the total uniqueness ratios for the 12 sites may be compared one with the other; the higher the ratio, the more unique the site. This is a way of measuring numerically the relative uniqueness of each of the sites chosen for comparison. The results of this uniqueness ratio technique, when applied to the 12 Idaho river valley sites, are given in table 2 on the page opposite.

There is a technical difficulty involved with the simple addition of the uniqueness ratios for the 46 factors at a given site. By the process of addition, each of the 46 factors is given essentially equal weight in determining the total uniqueness ratio. On further consideration of the list of 46 factors, one may decide that some are far more important than others, and therefore, for certain purposes, selected groups of the factors can be used for other analyses. Nevertheless, the uniqueness ratios for the 46 factors present a general means for quickly comparing a group of sites.

The uniqueness ratio techinque is objective in that it does not distinguish whether a given site is uniquely esthetic or uniquely unesthetic. The valley of the Little Salmon River near New Meadows (Site 7), for instance, was indeed the least attractive, most uninteresting, and unspectacular of the 12 sites surveyed. But because this site was different from the others in being a stream that was sluggish, algae-infested, murky, and slow flowing, it rated a high uniqueness ratio—the highest of all the 12 sites. It was unusual in a negative sense.

As can be seen in the table, the second largest total uniqueness score is Site 5, the Snake River in Hell's Canyon. In interpreting its rank order in total uniqueness score, one can say that Hell's Canyon was different from all others in ways that made it scenically interesting and therefore unique in a positive sense. Surprisingly, then, the two highest uniqueness scores represented the two sites that might be called the two opposite ends of the scale of esthetic interest.

A visual picture of the position of the various sites in the uniqueness scale can be obtained from the graph in figure 1 in which the ratios of human interest and biological uniqueness form, respectively, the ordinate (vertical, or y-axis) and abscissa (horizontal, or x-axis) with the physical uniqueness ratio written in numerical form next to each plotted point. It can be seen that Site 7 stands alone on the graph, primarily because of its uniqueness score on the biological scale—a result of its being the only polluted river among the sites surveyed. It can also be seen that Sites 5, 10, and 8 stand more or less alone because of low values in the biological factors and high values on the human interest scale. The graph, then, is an easy way of seeing that the total uniqueness score of Hell's Canyon, Site 5, and the polluted river, Site 7, are indeed at the opposite ends of a scale of landscape desirability.

Having demonstrated that the total uniqueness score does not involve personal preference or preference bias, one can now proceed to select combinations of factors from the checklist in order to perform additional types of analyses. In this study, checklist factors were chosen for their particular significance with regard to the impression that the

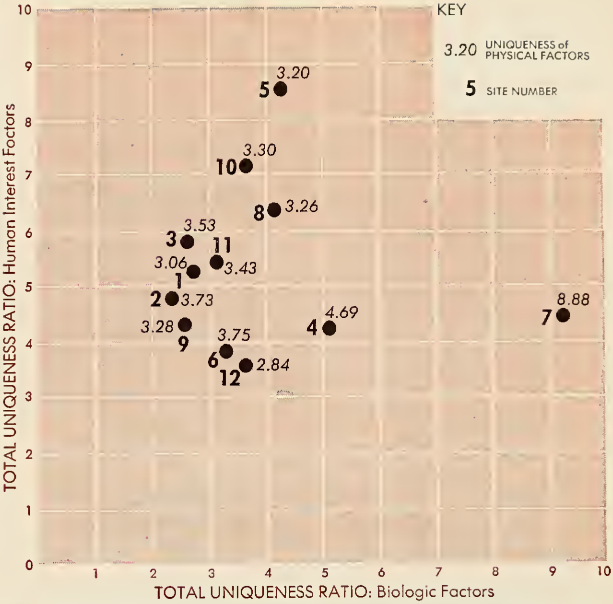


Figure 1: *The graph provides a measure of the relative uniqueness of each of 12 Idaho river valley sites in terms of the three groups of esthetic factors listed in table 1—biologic uniqueness is measured on the horizontal axis, human interest uniqueness on the vertical axis, and the physical uniqueness ratio is listed alongside each site number.*

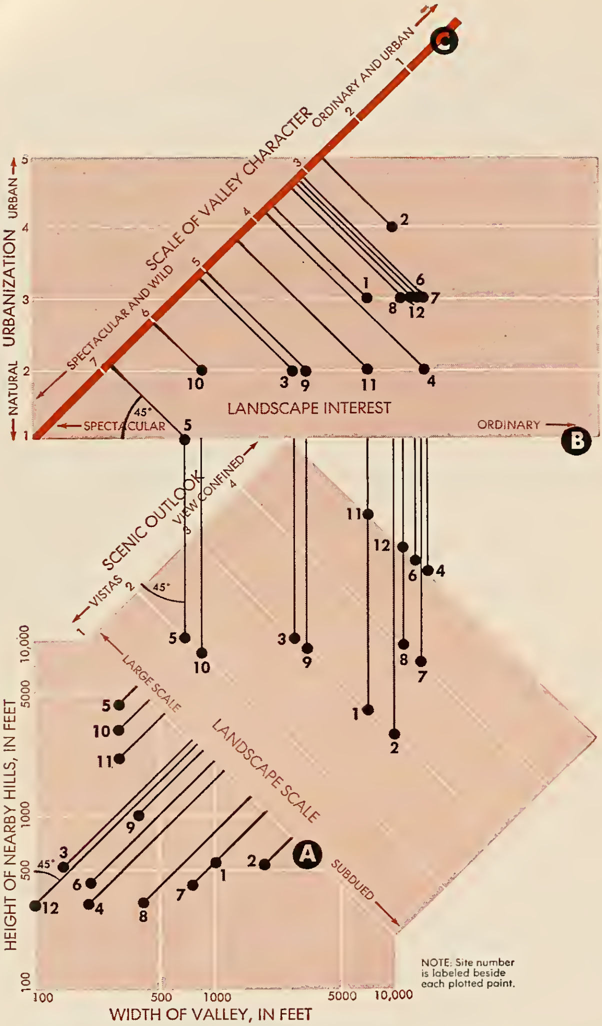


Figure 2: *"Height of nearby hills" plus "width of valley" equals "landscape scale." This value plus "scenic outlook" equals "landscape interest," which, combined with "degree of urbanization" yields "scale of valley character," a measure of the viewer's esthetic impression of the landscape at each site. See text for complete explanation.*

site gives to the viewer. The *selection* of factors does involve personal judgment as to which ones appropriately describe the landscape characteristics; but the selected factors themselves remain independent of this judgment. Factor selection may therefore be thought of as a subdivision of the objective basic data.

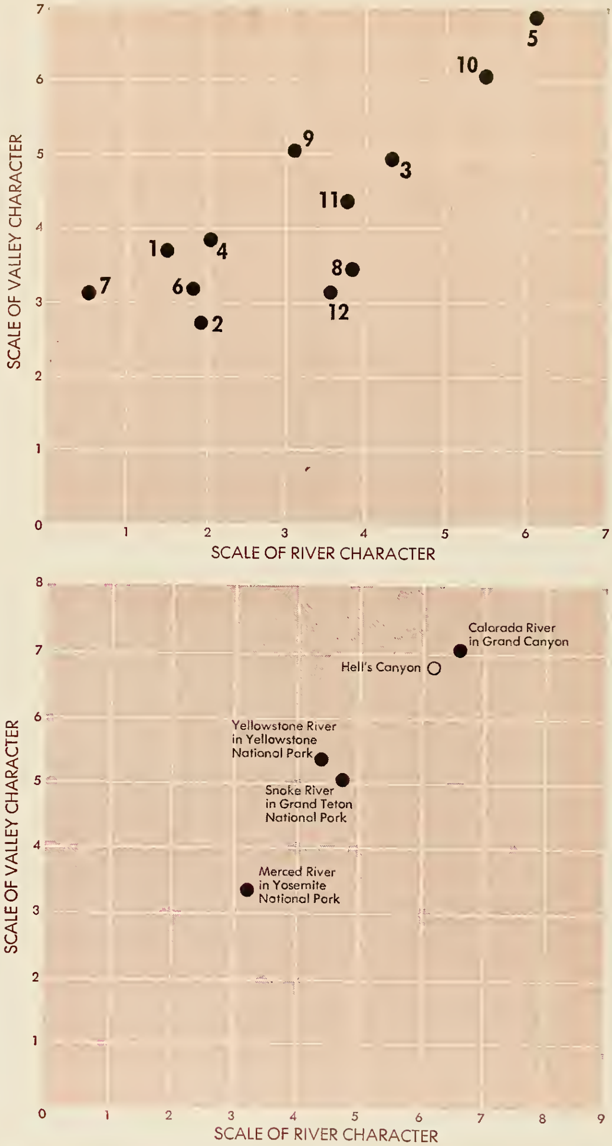
In this step factors were selected from the 46-factor checklist for the purpose of evaluating each site in terms of two characteristics—valley character and river character. Valley character I conceived as a *combination* of the scale or grandeur of the landscape, the availability of distant vistas, and the degree of urbanization. Valley character is certainly influenced, in part, by the bigness of landscape features. The spectacular character of many of the grandest scenic views in the world comes in large part from the presence of high peaks in close proximity to the valley floor from which the viewer is seeing the landscape. Specifically, where the valley floor is narrow and the adjacent hills or mountains exceptionally high, the viewer has the concept of a large-scale landscape. Where, in contrast, the valley floor is very wide and the adjacent hills low, the impression is one of flatness—the opposite of grandeur. The Swiss Alps are so spectacular because the valleys are narrow and the mountains are nearby and extremely high. The same can be said of the Teton Valley, in the Jackson Hole area of Wyoming. One, therefore, can make a scale that shows the combination between two of the measured factors, the width of the valley floor and the height of the adjacent hills or mountains, in order to evaluate this grandeur aspect of each site, or what I have here called "landscape scale."

The method of obtaining a value for landscape scale for each of the 12 Idaho river values is dependent upon a diagram, as shown in figure 2. For each of the sites, the height of the mountains was plotted as ordinate and the width of the adjacent valley floor plotted as abscissa on the bottom graph of the diagram. On this graph, Sites 5, 10, and 11 fall in a zone of large-scale landscapes (high mountains, narrow valleys) and other sites fall near the other end of the scale, which I call a "subdued landscape." To simplify the combination of height of hills and width of valley to the single value, landscape scale, the position of each plotted point in the bottom graph in figure 2 is projected orthogonally onto a diagonal line (line A). (The projection of each point is indicated by those lines leading from the points at a 45° angle upward and to the right in the lower graph.) Line A now serves as the line on which the sites are ranked according to their respective landscape scales. Having a value of landscape scale for each site, this joint value can be used for the construction of a new graph, as has been done in the central portion of figure 2, using line A as a horizontal, or x-axis.

At this point, it was reasoned that the impression of a landscape on the viewer is partly determined by this factor just derived, landscape scale, and partly by the "degree of view confinement." Where distant vistas are available in large-scale landscapes, one has the impression of spectacular scenery. In contrast, where the view is confined by heavy cover or by adjacent hills, the result is esthetically ordinary from the scenic point of view. Again this is one of the reasons why the Alps give a strong impression of scenic grandeur; not only is one looking out from a narrow valley to the high mountains immediately adjacent, but one can see up and down the valleys for long distances, viewing ranges of mountains as background vistas. In contrast, when one is in the bottom of a narrow, tortuous gorge, with no distant outlooks, as in certain portions of the Black Canyon of the Gunnison River in Colorado, the impression of the view is distinctly less spectacular.

On the central graph of figure 2, then, scenic outlook (the presence or absence of distant vistas) serves as the y-axis and landscape scale as the x-axis. And the position of each point on the graph is again projected upward at a 45° angle onto line B providing a scale which I have labeled "landscale interest." The position of each site on the landscape interest scale is thus a ranking of the individual sites using a combination of three factors: width of valley floor, height of adjacent mountains, and availability of vistas.

The scale of landscape interest can now be combined with another factor—degree of urbanization—which also affects the viewer's impression of the total landscape. The degree of urbanization is defined as the totality of buildings, houses, roads, utilities, and other earmarks of man-made change present in a given site. As before, using the scale of landscape interest as the x-axis, an ordinate, or y-axis, is constructed representing the degree of urbanization. This pro-



Figures 3 & 4: *The viewer's esthetic impressions of Idaho river valleys and river valleys in national parks are evaluated in terms of "valley character" and "river character." Relative to other locations, numbered sites falling in the upper right-hand portion of the graphs tend to have large rapid-flowing rivers, large-scale landscapes, scenic vistas and little urbanization. On the basis of this assessment, Hell's Canyon ranks second only to the Grand Canyon of the Colorado.*

vides the final or upper graph in figure 2. The sites having a combination of spectacular scenery and minimal urbanization fall in the lower left-hand zone of the upper graph, whereas those having ordinary and urban conditions fall in the upper right. The combination of landscape interest and urbanization, each given equal weight, is represented by another 45° projection onto the diagonal in the upper graph (line C), yielding a scale of what I call valley character. We thus constructed a ranking scale called "scale of valley character" representing a combination of four of the factors from the checklist in table 1: width of valley, height of adjacent mountains, availability of vistas, and degree of urbanization.

When the position of each of the 12 sites is considered on this final scale of valley character, we see that Sites 5 and 10, Snake River at Hell's Canyon and the wild reach of Salmon River at Carey Falls, are highly unusual. They are characterized by narrow valley floors, high adjacent mountains, availability of distant vistas, and little or no urbanization. All of the other sites in figure 2, fall to the right of Sites 5 and 10.

After combining the four factors contributing to valley character, we can perform a similar analysis on the rivers themselves, obtaining a measure called "scale of river character." Experience indicates that the grandeur or majesty of a river is dependent upon a combination of its size and apparent speed. Rivers tumbling over a succession of falls tend to be more impressive or esthetically appealing than those that appear sluggish. The latter characteristic is not so much dependent upon true velocity, which is usually poorly estimated by the untrained eye, as it is on the *appearance* of speed judged mostly by waves and surface riffles caused by rapids or falls. We therefore wish to find a combination of factors that gives the viewer the impression of the river's grandeur itself. For this we use river width, river depth, and the presence or absence of rapids, riffles, and falls, chosen from the checklist factors.

Eventually we arrive at a ranking of the sites according to river character; those rivers that are wide, deep, and have rapids, falls, and riffles rank high on this scale. In this instance, Sites 5 (Hell's Canyon) and 10 (Salmon River at Carey Falls) again outrank the other locations. As the last step in our analysis, we use a graph to compare the 12 sites according to both valley character and river character (figure 3), and thereby obtain a final rank reflecting a total of 7 of the factors chosen from among the 46 on the initial checklist.

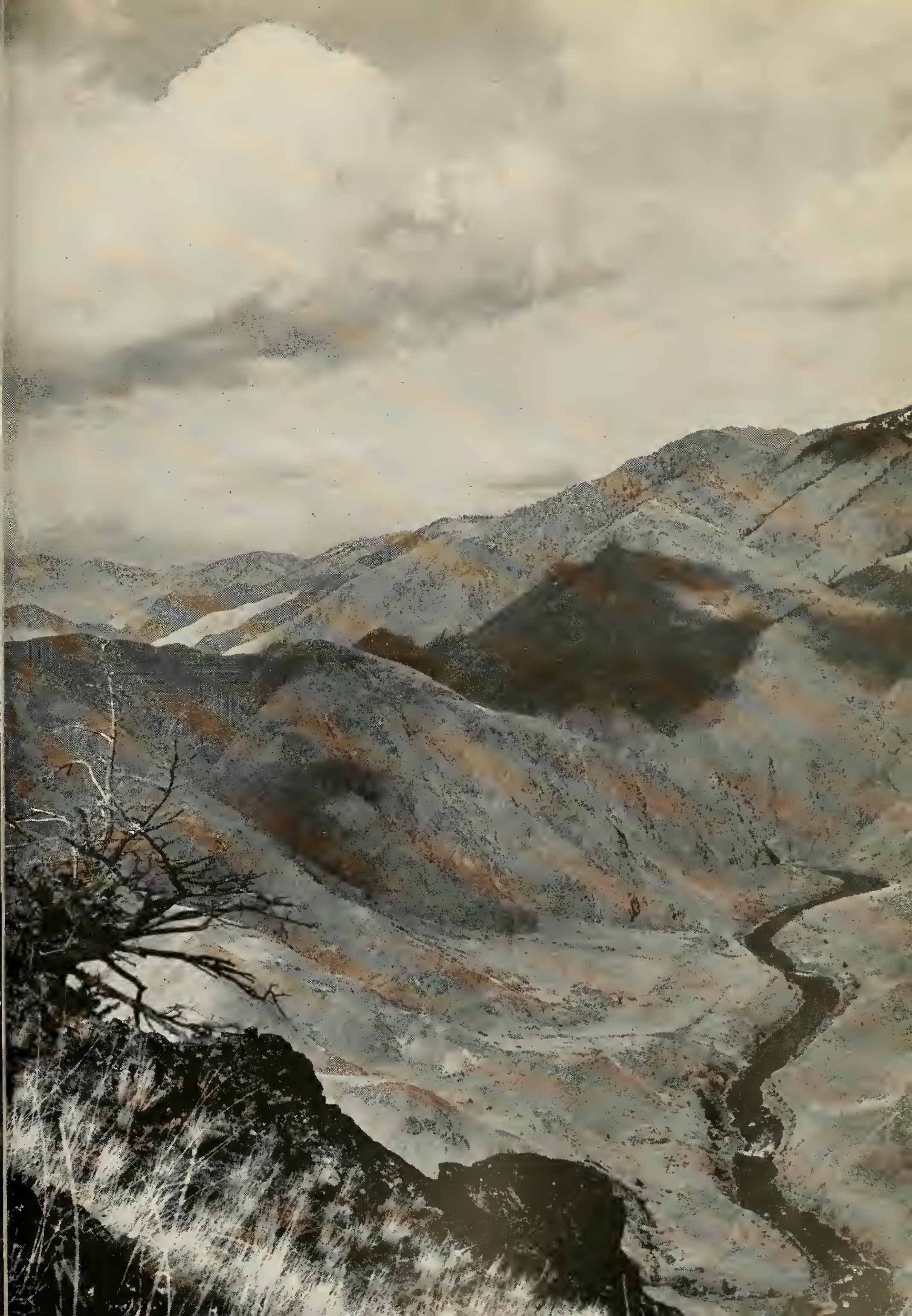
It can be seen that on this graph Hell's Canyon is indeed unique, for it falls in the farthest position in the upper right-hand part of the graph. Nearest to it again is Site 10, the wild reach of the Salmon River near Carey Falls. Nearly all of the other sites fall in the central cluster in the center of the graph. Site number 7 (Little Salmon near New Meadows), the least interesting of all those surveyed, falls at the opposite end of the scale, appearing in the lower left-hand portion of the figure.

Having evaluated the Idaho sites, a new comparison was made in which Hell's Canyon of the Snake was viewed along with rivers in four areas officially recognized as having great natural scenic beauty. These are the Merced River, in Yosemite National Park in California's Sierra Nevada; the Grand Canyon of the Colorado River; Wyoming's Yellowstone River near Yellowstone Falls in the national park; and the Snake River in the Teton National Park below Jenny Lake, again in Wyoming. How does Hell's Canyon compare with them?

The same kinds of data that were used in the construction of the graphs just described were tabulated for Hell's Canyon in combination with these four national park rivers. A similar set of graphs was derived, the results of which are shown in figure 4. In this comparison, it can be seen that the points representing Hell's Canyon and Grand Canyon fall nearly together in the upper right-hand portion of the graph. They are comparable in the combination of valley character and river character and stand in exceptional positions. By comparison, the Merced River in Yosemite is of a lower order of interest. Truly the Yosemite Valley as a whole is one of the great scenic beauty spots of the world, but the river within the valley is not of a special character. As far as the Snake River in Teton Park is concerned, its position in the center of the graphical comparison can be attributed in part to the higher degree of urbanization present there than in the Grand Canyon or Hell's Canyon, and to the comparatively large width of the valley floor, a characteristic that makes the Snake River at that point less of a grand spectacle than either Hell's Canyon or the Grand Canyon. Relatively great urbanization, along with the absence of scenic vistas, also diminishes the site of the Yellowstone River.

The result of the data collection and analysis indicates that it is possible to set up a list of factors that influence the esthetic nature of a given location. The factors can be considered all together, in this case by the computation of a total uniqueness ratio, or they can be selected and used in various combinations to express certain aspects of a landscape's characteristics. It is hoped that the study will indicate both the need for, and the possibilities of, objective description of landscape. Specifically, this analysis shows that the Hell's Canyon of the Snake River, the site proposed for a hydropower dam, has unique characteristics that give it an exceptional esthetic rating and place it in a category shared by few other landscapes within the United States.

Common scenery? Above average? Unique? The Leopold study seeks to answer these questions by assigning numerical values to "landscape scale," "degree of urbanization," and to other features that contribute to a region's esthetic impression. The study concludes that Hell's Canyon, right, is an area whose superb esthetic qualities are shared by few other landscapes within the United States.



In that portion of the Appalachian Mountain Range that forms the border between Tennessee and North Carolina, below the Great Smoky Mountains National Park, lives one of the least-known exotic animals in America—the European wild boar.

The territory of this immigrant boar covers a rugged region, heavily forested with hardwoods and pines, and contains hundreds of the dense laurel tangles that are so impenetrable to man and other animals that they have been appropriately named "laurel hells" by the local residents. In the past, this mountain region was populated by mountaineers, but since its inclusion in the Cherokee National Forest on the Tennessee side, and the Nantahala National Forest on the North Carolina side, only a few interior holdings remain. The small, scattered clearings made by the former residents have mostly reverted to wilderness.

Although the wild boar is considered a game animal in both Tennessee and North Carolina and is hunted each fall, its inaccessible and limited range and small population—estimated at about 1,200—account for its relative obscurity.

Formerly referred to as the Russian wild boar, the animal is now known locally as a "Rooshian," the adjective having become nominal. Although the species, *Sus scrofa*, is found in Russia, the Appalachian stock came originally from Germany. It was introduced into these mountains in 1912 by George Gordon Moore, an American representing a group of English capitalists. For entertaining the Englishmen on their visits to America, he had built a lodge and a game refuge at Hoopers' Bald, atop the Appalachians on the North Carolina side. The lodge was a large log structure with indoor bathrooms—something totally unknown in that region in 1912 and a source of much amazement to the mountain residents.

The wild boars—14 young animals weighing approximately 50 pounds each—were imported and brought to the refuge along with 8 North American bison. A later shipment of animals included 4 additional bison, 6 Colorado mule deer, 14 elk, and 34 black bears. These all eventually escaped but, as far as is known, only the boars survived and reproduced.

The game refuge, some 1,500 acres in size, was surrounded by a fence of double-strand woven wire, which enclosed all the animals except the boars. A special enclosure of chestnut rails had been constructed for them. Apparently those who built the pens had no idea of the wild boar's almost incredible strength, nor of its dislike of captivity. At any rate, the boars soon escaped from this enclosure and scattered into the mountains, forming the nucleus herd from which today's animals are descended.

As the number of wild boars began to increase, the mountaineers, who had herds of free-roaming domestic hogs, made an earnest effort to exterminate them. Male wild boars are remarkably aggressive and virile, and were able to drive off the domestic boars and mate with the "mountain rooter" sows, producing a crossbreed that was both wild and difficult to fatten. When penned—if they could be caught—these crossbreeds would eat only enough to blunt the edge of their hunger.

Because of this early crossbreeding, it is doubtful if there remains today a single full-blooded descendant of the original group. Two factors, however, have worked toward restoring the animals to their earlier coloration and other characteristics. First, when the national forest was formed, the residents of the area moved out and the incidence of free-roaming domestic hogs was radically reduced; thus there was less chance for crossbreeding. Second, regulated hunting began about 1936, and those wild boars with the strongest infusion of domestic blood were more easily taken by hunters, so the fittest or, rather, the wildest, animals survived.

The European wild boar bears little resemblance to the domestic hog. It has a heavy coat, varying in color from reddish brown to black. The undercoat is woolly or furry, and the outer coat has long, stiff guard hairs,

WILD BOAR OF THE APPALACHIANS

by H. LEA LAWRENCE

usually split at the ends. Although domestic hogs tend to be heavy in the hindquarters, the wild boar has massive shoulders and a bristly mane that gives the back of the neck a humplike appearance. When the boar is angry or excited, these bristles stand up and the ears point straight out to the sides.

Adult animals weigh from 150 to 400 pounds, with rare specimens up to 500 pounds. One dominant and persistent characteristic of the species is the coloration of the young. They have longitudinal stripes and splotches of brown and yellow that disappear at about six months.

Adult males and females both have pairs of tusks, although the males' are larger. These tusks, which are comparable to canine teeth, emerge from the same point in the upper and lower jaws and are self-sharpening, that is, they rub together when the mouth is closed so that the friction maintains the sharp edge. The boar uses his tusks in rooting for food and as defensive tools.

Wild boars are omnivorous. Nuts, grubs, salamanders, birds' eggs, grass, tuberous roots, berries, the defenseless young of other animals, and birds are taken when available. They also damage the lateral root systems of certain trees—particularly the pitch pine—another food they like.

Boar "wallows," similar to those of domestic hogs, are commonly found in the boggy spots where small streams flow out of the valleys. These wallows are used primarily in the summer months when the boars wish to cool off or to gather a layer of mud on their bodies as protection against insects. After wallowing, wild boars rub themselves against trees—usually the same trees are used by all the animals in a given area.

The boar has few natural enemies. Stray dogs, bobcats, foxes, and bears may destroy an occasional small pig, but not even the bear is a formidable adversary for an adult boar, which is extremely vicious when cornered. In most cases a large male is more than a match for a pack of hunting dogs.

Unlike his domestic cousin, the wild boar is capable of quick, deft movements, especially those that bring the tusks into play. There are many authenticated instances of men being treed either by an individual or a herd of wild boars, and hunters have been injured by the charges of these enraged animals.

In recent years, the Tennessee Game and Fish Commission has conducted a European Hog Research Project at the Pheasant Field Station, within the Tellico Wildlife Management Area, in an effort to learn more about this animal. The first experiments dealt with attempts to determine the age of a wild boar by weighing the eye lens, a procedure that is successful in rabbits, foxes, antelope, and certain species of mice. It was also hoped that the weight of the eye lens could indicate aspects of nutrition, and any differences between pen-reared animals and those in the wild. This project was discontinued when it was found that the weight of the animals (and, consequently, the eye lens) varied too greatly both in pen-reared and wild stock.

Objectives of the present study include: determination of the gestation period, length of time between parturition and the next breeding period, average litter size, tooth eruption data, periods during the year when conception can take place, presence of external and internal parasites, food habits and nutritional needs, susceptibility to diseases, blood studies, and so on. Boar are vaccinated against those diseases that affect domestic hogs, since it has been determined that they can contract these diseases if they have contact with affected animals, even though no instance of infection has been noted in wild stock.

At present, the wild boar herds in this region are on the increase, and the promise of this unusual species being preserved for future generations is practically assured. Considering that their history on this continent dates back little more than 50 years and to 14 individuals, and remembering the pressures they have encountered, their prospects look particularly bright.

SKY REPORTER

SAMPLING THE MOON The first thorough analyses of moon samples brought back by Apollo 11 will not be published until early next year, but the scientists' first impressions, offered at a series of Houston news conferences, provided enough detail for exciting speculation.

The possibility of volcanism on the moon, once thought to be cold and lifeless, remains at least as strong as it was before the landing. The first rock samples examined in Houston were igneous (heat formed) and full of cavities similar to those left by gases in hot lava. Harold C. Urey, a Nobel laureate and former cold-moon proponent, said they looked as though they could be lava flows.

The biggest surprise also involved heat. The first lunar soil sample contained very bright bits of yellow and brown glasslike material. The fragments were small, no more than one-fiftieth of an inch long, and rounded. Scientists speculate that they are formed when lunar material is vaporized by the heat of a meteor impact and then condenses into the glassy state and falls back to the surface.

While volcanism remains an open question, the seismometer left behind by the astronauts has ended all doubt about whether the moon is seismically active. In the first weeks following the landing, the automatic device recorded two types of activity: quick events that could be meteor impacts or "moonquakes," and slower events that produced seismic records like those of landslides on earth. The landslides appeared to be occurring in areas that were then hottest on the moon; the accepted lunar temperature range of 500 degrees, unlike anything on earth. is believed sufficient to crack lunar surface material and generate landslides. This could explain how the older craters were eroded.

AND AWAY WE GO The earth rotates on its axis and revolves around the sun; the sun and its entourage revolve around the galactic center. Where is the Galaxy going? And what can we use as a frame of reference to find out?

Fifty years ago astronomers thought they had a frame of reference in the luminiferous ether—a mysterious substance pervading the universe—which was invented to explain how light traveled across otherwise empty space. Experiments produced negative results, however, and the ether joined the doctors' humors and the biologists' spontaneous generation of life on the historical curiosity shelf.

Now, unexpectedly, astronomers do have something pervading the universe that they can use as a reference to measure the earth's (and the Galaxy's) motion. It turns out that the universe is filled with very weak microwave radiation believed to be the residue of the "big bang" that created the universe tens of billions of years ago. It appears to come from every direction with equal intensity.

This characteristic, known as isotropy, suggested a new experiment to Edward K. Conklin, a graduate student working under Ronald N. Bracewell at the Radio Astronomy Institute at Stanford. Conklin reasoned that if the earth is moving through an isotropic sea of radiation, the earth's velocity should cause the radiation to appear stronger in the direction the earth is moving. After making corrections for the known motions of the earth, any remaining anomaly would indicate the previously unknown motion of the earth and the entire Galaxy.

Conklin made his measurements with two radio telescopes 12,500 feet above sea level. Reporting results in the British journal *Nature*, he said he found the postulated difference in radiation strength in the direction of the northern constellation Canes Venatici. The size of the difference implies that the earth is moving in that direction at 160,000 miles per hour.

A WHOLE NEW SPECTRUM A decade of painstaking work by a physicist at the University of Maryland has paid off in spectacular fashion: a whole new spectrum for studying the universe. Joseph Weber has succeeded in detecting gravity waves—gravitational radiation—from other astronomical bodies.

Weber's detectors look nothing like telescopes. They are aluminum cylinders about five feet long and two feet in diameter. Gravitational waves deform the aluminum just enough for sensitive electronics to be activated. One of the detectors is at the Argonne National Laboratory outside Chicago; the others are in Maryland, linked by telephone lines. Separation ensures that events observed simultaneously on two recorders are not caused by the same local effect.

In a recent 81-day period, 17 events were recorded by two or more detectors. Weber has calculated that if these were accidental coincidences, some would occur every 144 days, others, once every 70 million years.

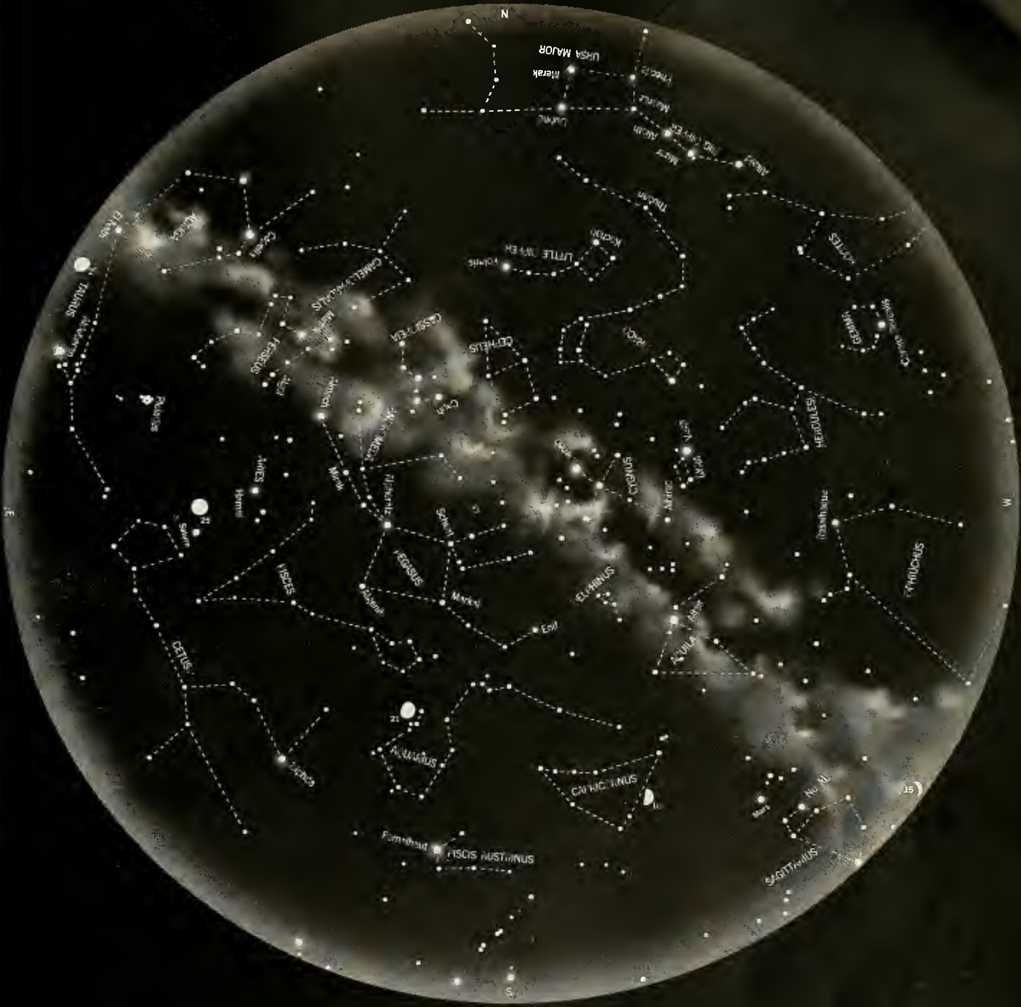
Writing in *Physical Review Letters*, Weber outlines the precautions taken against spurious signals. He continues: "We must therefore conclude that all of the coincidences are neither accidental nor due to seismic or electromagnetic effects. This is good evidence that gravitational radiation has been discovered."

MORE MOONS FOR JUPITER An Australian radio astronomer, E.K. Bigg, has found evidence for two very small, undiscovered moons circling Jupiter between Io, one of the bright Galilean satellites, and the very tiny moonlet Amalthea, usually designated simply as satellite V.

The existence of a thirteenth Jovian moon was first proposed in 1967. Bigg decided to examine radio emissions coming from Jupiter to see if they were disturbed by the passage of the postulated moon. The effect of Io's passage on the radio signals, although not its cause, is well-known. He reports in *Astrophysical Letters* that he found two well-defined modulations in the signal.

Bigg estimates that the new moons are no larger than six miles in diameter; and that they are no brighter than 16th magnitude as seen from the earth.

John P. Wiley, Jr.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CELESTIAL EVENTS

Last-quarter moon in October is on the 3rd, and new moon is on the 11th. The moon then becomes a crescent in the evening sky and reaches first-quarter on the 18th, full moon on the 25th.

Mars and Saturn are in the evening sky: Mars setting before midnight, Saturn remaining visible all night. Venus is a bright morning star, low in the east, and Mercury may be seen in the morning sky in the middle weeks of the month. Jupiter passes from the evening to the morning sky, and may be seen as a morning star near Venus late in the month.

October 7: Mercury becomes stationary and resumes direct (east) motion.

October 9: Venus, in conjunction with the old crescent moon at 2:00 A.M., rises to the right and above the moon. Jupiter, in conjunction with the sun, enters the morning sky.

October 10: Mercury is between the crescent moon and Venus this morning.

October 14: Mercury, at greatest elongation in the morning sky, is about 16 degrees above the horizon at sunrise.

October 17: Mars is to the right of the moon. The star nearer to the moon is Antares, in Scorpius.

October 21: The Orionid shower reaches maximum, with no moonlight during morning hours. Meteors are few (about 25 per hour), but often bright.

October 25: Tonight's full moon is the hunter's moon. Saturn rises to the right and below the moon and precedes it across the sky, slowly separating from it during the night.

October 28: Saturn is at opposition, located opposite the sun as viewed from earth. The planet now rises at sunset and sets at sunrise.

THOMAS D. NICHOLSON

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 9:20 P.M. on October 1; 8:25 P.M. on the 15th; and 7:20 P.M. on the 31st, but it may be used for about an hour before and after those times.

Tchikrin

A central Brazilian tribe and its symbolic language of bodily adornment

by Terence S. Turner
photographs by Claudia Andujar

Something profound in the nature of man, in his role as a member of a society or culture, seems to be bound up with his universal urge to decorate or transform the surface of his body. We might well ask if the boundaries and appendages of the body carry some universal symbolic significance, and if so, whether their adornment is a way of focusing and expressing this symbolic meaning. In other words, bodily adornment may be a kind of symbolic language. But if it is, how can we decipher its "message"?

The Tchikrin, one of the least-known peoples of the central Brazilian wilderness (a region virtually unpenetrated by Brazilian settlers), are among the world's most exotic body adorners. Their elaborate body painting, their penis sheaths and earplugs, and their spectacular lip plugs raise the question of the symbolic significance of bodily adornment in a uniquely compelling way.

The Tchikrin are the northernmost group of the large Kayapo tribe, a member of the Ge-speaking linguistic family. Their villages are built in a circle around a large central plaza, each house the residence of an extended family. Throughout their lives the women remain in the households of their birth. Men, however, leave their maternal houses at about the age of eight, when they move to the men's house, which is usually built in the center of the plaza. Only after consummating their marriages by fathering a child do men move into their wives' houses.

The pattern of a man's life cycle focuses on his movement from his maternal household, to the men's house, to his wife's household. Before, during, and after these moves, he is classified according to named age grades, each with its distinctive social properties, styles of body painting and hair cutting, and bodily ornaments. There is a separate and rather different system of age grades for women.

Newborn and nursing infants of both sexes are classified in a category whose name means "little ones." They are the most elaborately ornamented Tchikrin of any age. A few days after a baby's birth, its ear lobes—and if it is a boy, its lower lip—are pierced, usually by its father. Cigar-shaped earplugs of reddened wood are inserted in the ear lobes and replaced from time to time with larger ones until the holes in the lobes have become quite large. A narrow dowel or string of beads is also inserted in a boy's lower lip, but this ornament is not enlarged until much later in life. At the same time, the mother crochets cotton bands, reddens them with paint, and fastens them around the infant's wrists, ankles, and knees. When these grow too tight they are cut away and replaced with larger ones.

The cast-off arm and leg bands and the discarded sets of earplugs are saved by the mother in a special pouch, together with the baby's desiccated umbilical cord. The bands and plugs constitute a sort of record of the baby's growth—analogous, in a way, to a modern mother's "baby book." When the baby grows older the father takes its pouch and hangs it on, or buries it at the root of, a

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In a gesture typical of the gay and open spirit of most Tchikrin festivals, five older girls include a younger girl, not yet a "given one," in their dancing line.

hardwood tree in the savanna. This gives the child a magical infusion of strength and well-being, symbolically neutralizing the weakness and vulnerability of its infancy, for hardwood trees are potent sources of strength, endurance, and health in Kayapo ritual symbolism. The red color of the earplugs and cotton bands serves much the same symbolic function—the fostering of growth and strength—for red is associated with health, energy, and vitality.

Body painting is an outstanding feature of the decoration of both male and female babies. Mothers, grandmothers, or other kinswomen, using a stylus made of the center rib of a leaf, draw complex linear patterns over the entire body of the child. Women also paint each other in this complex style, but except for rare ceremonial occasions, they are not allowed to paint men and older boys. Since only women use the stylus method, the men paint each other in a rougher, simpler pattern.

When a boy is weaned, learns to talk well, and can walk easily, which usually happens between the ages of three and four, he "graduates" from the age grade of little ones to that of "boys about to enter the men's house." This transition, like most changes from one major age category to the next, is accompanied by changes in bodily adornment and features of grooming such as hair style. The boy is now stripped of his infantile ornaments (earplugs and cotton arm and leg bands) and his hair is cut short. Boys of this age spend little time with their mothers and sisters; they already form a quasi-independent masculine play group, a precursor of the age sets and societies of the men's house. Their semi-independence of their maternal families and passage out of infancy are expressed not only by doffing their infantile ornaments and long hair but also by the infrequency with which their mothers paint them in the time-consuming linear "stylus" fashion. Boys of this age are far more apt to be painted with broad areas or bands of black and red, applied directly with the hand.

At about the age of eight (the Tchikrin do not reckon age by number of years, but by broad criteria of physical size and maturity) a decisive event occurs in a boy's life. In a brief but solemn ceremony, an unrelated man called a "substitute father" comes to the boy's maternal house, where he sits waiting silently with his wailing father and mother. The substitute father leads him out into the plaza and paints his body solid black. He then takes the boy by the hand into the men's house, which becomes his home.

He is now cut off from the world of family and blood relationships. The painting ritual thus marks the end of childhood for the boy and he enters a new age grade called "the painted ones." From this time on the boy will never again (except for rare ceremonial occasions) be painted by a woman. Henceforth, he will be painted only by other men, in the rough hand style or with a stamp made of a fruit rind that is cut in a simple pattern.

At puberty, boys go through a brief ceremony in which they are given penis sheaths to wear. After this they may replace their beaded lip ornaments with small versions of the mature men's lip plugs. They also let their hair grow long again, in the style of adult men and women.

Hair is associated with sexual powers. Long hair connotes full participation in sexually based relationships. However, since infants as well as mature adults have long hair, it is evident that the Kayapo notion of participation in sexual relations is considerably different and more complex than our own. For the Kayapo, there are two modes of sexual participation. One, like our own culture's conception, consists of the mature individual's active exercise of his sexual powers, above all in the relationship between husband and wife. The other, for which our culture has no counterpart, consists of the infant's passive biological (and social) dependence on the family, a dependence founded upon its parents' procreative sexual relationship. The Kayapo think of an infant before it is weaned more as an extension of its parents' biological being than as an independent individual. It is conceived as still participating in the biological communion with its parents that it enjoyed in the womb.

Preparing for a special ceremony, Tchikrin husband is painted by his wife. Normally, she can paint only other women and children. On following pages, "bachelors" lean close to hear ritual directions from man of "fathers" age grade. Their ceremonial regalia includes armbands, headdresses, and bandoliers of inaja palm leaves.

This is understandable in view of the Kayapo notion of pregnancy—that the fetus grows by nursing inside the mother. Birth, therefore, does not fundamentally change the relationship between mother and infant; it merely transfers its locus from inside her body to outside. The father is also involved in this biological connection, for while the child is still in the womb, his semen—like the mother's milk—is thought to nourish the fetus. The birth of the baby terminates this direct physical link with the father, a rupture that renders the father's relation to his newborn child extremely delicate and fraught with danger. In order to minimize this danger, for several days the father abstains from physical exertions or "strong" and "dangerous" acts, such as killing animals, that might otherwise have a deleterious impact on the child's health.

Because weaning marks the end of full physical communion between mother and child, a child's hair is cut at this time. Short hair symbolizes the attenuation of his direct biological connection with others, a connection that is restored when the child grows to physical maturity and is ready to exercise his own sexual powers. The same principle underlies the custom of cutting the hair as a gesture of mourning for the death of a spouse, sibling, or child. The effect of such a kinsman's death is equivalent to weaning, since it suppresses ties, which the Kayapo conceive as based on an intimate biological bond, between the person who has died and the survivor.

Nursing infant wears large wooden earplugs characteristic of "little ones." Even at this early age, eyebrows and eyelashes are plucked.

A distinction is made between hair of the head and hair of the face and body. Facial hair is customarily plucked as a matter of ordinary grooming of both sexes and all ages. Here again, however, the sexual significance of hair emerges in one of the more stereotyped forms of Kayapo love-play—it is considered to impart a special *frisson* for lovers to pluck a stray eyebrow or eyelash from each other's faces with their teeth.

The Kayapo recognize, in ritual and other ways, the correlation between the development of sexual maturity and the weakening of family ties. They attempt to offset this tendency toward the isolation of the individual from social control by developing alternate forms of communal integration of the individual's developing sexual powers. Public recognition of the individual's steps toward sexual and social maturity is ritually associated with changes in his social status that move him inexorably toward marriage and the founding of his own family.

The penis sheath is the symbolic expression of the social control and regulation of mature male sexual powers. It is bestowed at puberty, and only after the sheath-bestowing ceremony is a youth's hair allowed to grow long again. Sheath and coiffure are thus complementary aspects of the public recognition of the growing boy's biological sexuality and, at the same time, of its integration into the social order.

Penis sheath, lip plug, and long hair symbolize the community's recognition of a boy's physical maturity, but they do not confer on him the right to put his newly recognized powers into practice. He only wins this right by going through the initiation ceremony, which is completely distinct from the penis-sheath rite and centers around the ceremonial "marriage," or betrothal, of the boy. This ritual marriage is not considered binding: it only establishes in principle the boy's ability to have sexual relations and marry any girl he chooses. Going through the initiation ceremony entitles a boy to move up into the age grade of "bachelor youths."

Using a stylus made of the center rib of a leaf, one woman carefully applies decorative facial paint to another.

Bachelor youths eventually become engaged in earnest. Engagement, a private arrangement with a girl and her parents, culminates in the girl's pregnancy and the birth of a child. This event marks the climax of the youth's transition from boyhood to mature manhood, and he thereupon passes from the symbolic tutelage of his substitute father, who has presided over the successive stages of the long initiation process. Having founded his own family, he is definitively free of his lingering childhood bonds to his maternal family. He is entitled to move out of the men's house into his wife's house, and simultaneously to graduate to the age grade of mature men, significantly called "fathers." Fathers make up the membership of the men's societies, which meet (but do not reside) in the men's house and conduct the political affairs of the community.

These vital transitions in a man's life are expressed by a final transformation in bodily ornamentation—the replacement of the youth's small lip plug by a saucerlike plate, which may reach a diameter of four inches, or an alternative form, a long cylinder of rock crystal or wood. As an expression of mature manhood, this extraordinary ornament has a complex significance.

One aspect of its symbolism is implicit in the contrast between the lip plug and earplug. Both hearing and speaking have specific social associations for the Kayapo, and these associations relate to each other as complementary passive and active values. Hearing is a passive activity. The word *mari* 'hearing' signifies understanding in the passive sense of knowing about something. Hearing in this sense is used in the common idiomatic expression of affirmation of specific relationships. If a man has good relations with his father's side of the family, for example, he says, "I hear them strongly" (*mari taytch*). Speaking, on the other hand, is perhaps the most fundamental social act of self- assertion, and its assertive connotations are highly elaborated and associated with mature masculinity. Flamboyant oratory is one of the major activities of Kayapo men.

The huge lip plugs of the father's age grade are consciously associated with this flamboyant oral assertiveness. The dynamism and oral aggressiveness of adult male public behavior rests on a foundation of sexual assertiveness: graduation to father status depends on a man's actually siring a child. The fulfillment of male sexual powers in paternity and the resulting integration of men in specific family units are, in other words, what earn men the right to aggressive, oral self-assertion in the men's house. The full-size lip plug, in its double character as the badge of paternity and the symbol of mature male oral aggressiveness, precisely embodies this relationship between the phallic and oral components of adult masculinity, and by the same token, of the family and communal levels of men's social relations.

If paternity is the criterion for communal recognition of male maturity, then infants assume a reciprocal importance as the "objective correlatives" of manhood in both its biological and social aspects (phallic power and family membership). Infants, then, are the passive extensions, or corroborations, of the father's sexual powers and social position as *paterfamilias*. The relation of the infant to its father is in fact analogous to that between hearing (in its Kayapo sense of passive affirmation of social relations) and speaking (considered as social self-assertion). The symbolic complementarity of infantile earplug and paternal lip plug neatly expresses this social complementarity, especially when the phallic connotations of the cigar-shaped earplugs are taken into account. The same considerations explain why women do not wear lip plugs and why neither adult men nor women wear earplugs.

In contrast to the man's pattern of life, for the Tchikrin woman there is no dramatic transformation in social relations involved in biological parenthood. The residence rule dictates that women spend their entire life cycle in the households into which they are born. The contrasts between female and male body decoration reflect the difference in social pattern.

Girls, like boys, dispense with their earplugs and have their hair cut upon weaning. They continue, however, to wear crocheted red cotton arm and leg bands—in recognition of their continuing membership in their parental families—until they are judged ready for childbearing.

At about the age of eight—the same age that a boy leaves home to enter the men's house—a girl is initiated into sexual relations under the aegis of a special ceremonial guardian. This event marks her graduation into the age grade of "given ones." In all probability the name indicates (the Kayapo have no explicit explanation for it) that girls of this age grade are considered to be "bestowed" upon the initiated men of the village for sexual purposes. Given ones are expected to take an active and enthusiastic part in communal dances; dancing in groups during communal rituals is, in fact, their chief collective activity.

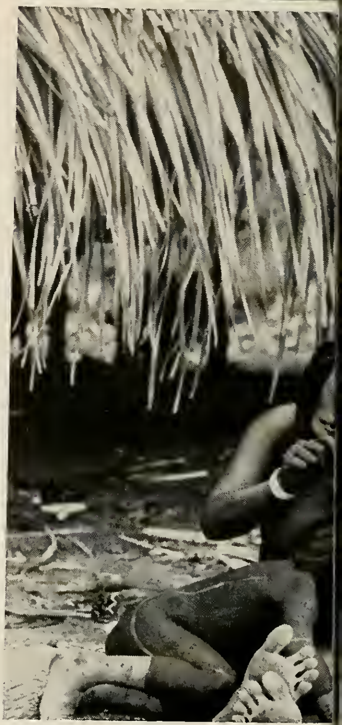
The rite that recognizes that a girl has reached the stage of potential motherhood bears many resemblances to the boy's ceremony of induction into the men's house, and has the same purpose of formally dissolving the childhood bond to the parental family. In the girls' ceremony, a "substitute mother" paints the girls' thighs, breasts, and upper arms with broad black stripes, and cuts off their arm and leg bands (the symbols of parental ties). Henceforth, they are known as "black-thighed ones," and are considered ready to consummate their courtships with one of their suitors in marriage by giving birth to a child. Only this event differentiates women in a social sense from their parental families, since it enables them to set up distinct families of their own within the household they share with their parents. Independence from the parental family (established much earlier for boys by their move to the men's house) is the prerequisite for social recognition of their reproductive powers as fully developed, autonomous, and "adult." This recognition, as we have seen, is symbolized for both sexes by long hair. For this reason, a woman is allowed to wear her hair long only upon the birth of her first child.

After attaining black-thighed status, a girl is qualified to join one of the mature women's societies, whose members gather regularly, every few weeks or so, to paint each other. It is interesting that while adult women often use the hand technique of the mature men to paint each other, they may equally well employ the stylus method used by mothers to paint their infants. Men and boys are almost never painted in this style after they leave home for the men's house; the use of it by adult women is another mark of their greater continuity with the social circumstances of childhood.

The typical daily routine of a Tchikrin mother, however, has relatively little place for collective activities. She must nurse her baby and care for her younger children. One of

Bending under load of firewood and garden produce, Tchikrin woman trudges homeward along jungle path. At far right, she heats stones in fire, then cooks leaf-wrapped food in "oven"—a mound of the preheated stones, leaves, and earth.

Another time-consuming chore: after freshly painting her in fine, parallel lines, a mother delouses her daughter. At far right, day's end may leave time for wife to relax with husband on typical platform bed of split logs.



the most frequent maternal chores is delousing, which, interestingly enough, conforms to a sexually asymmetrical pattern partially similar to that of body painting. Women delouse children, other women, and men (usually their husbands), but men do not delouse women.

A woman's day usually includes a trip to her garden or perhaps an expedition to gather firewood, normally cut by women. She is likely to return from either heavily burdened. She must cook for her husband and children (each nuclear family within the household gardens and cooks for itself). The Tchikrin, like other members of the Ge linguistic group, lack pottery. They cook by baking bundles of food wrapped in leaves, in a temporary earth "oven" composed of heated stones, leaves, and earth. At the end of the day a woman may get a little time to relax with her husband on the family bed, a mat-covered platform of split logs.

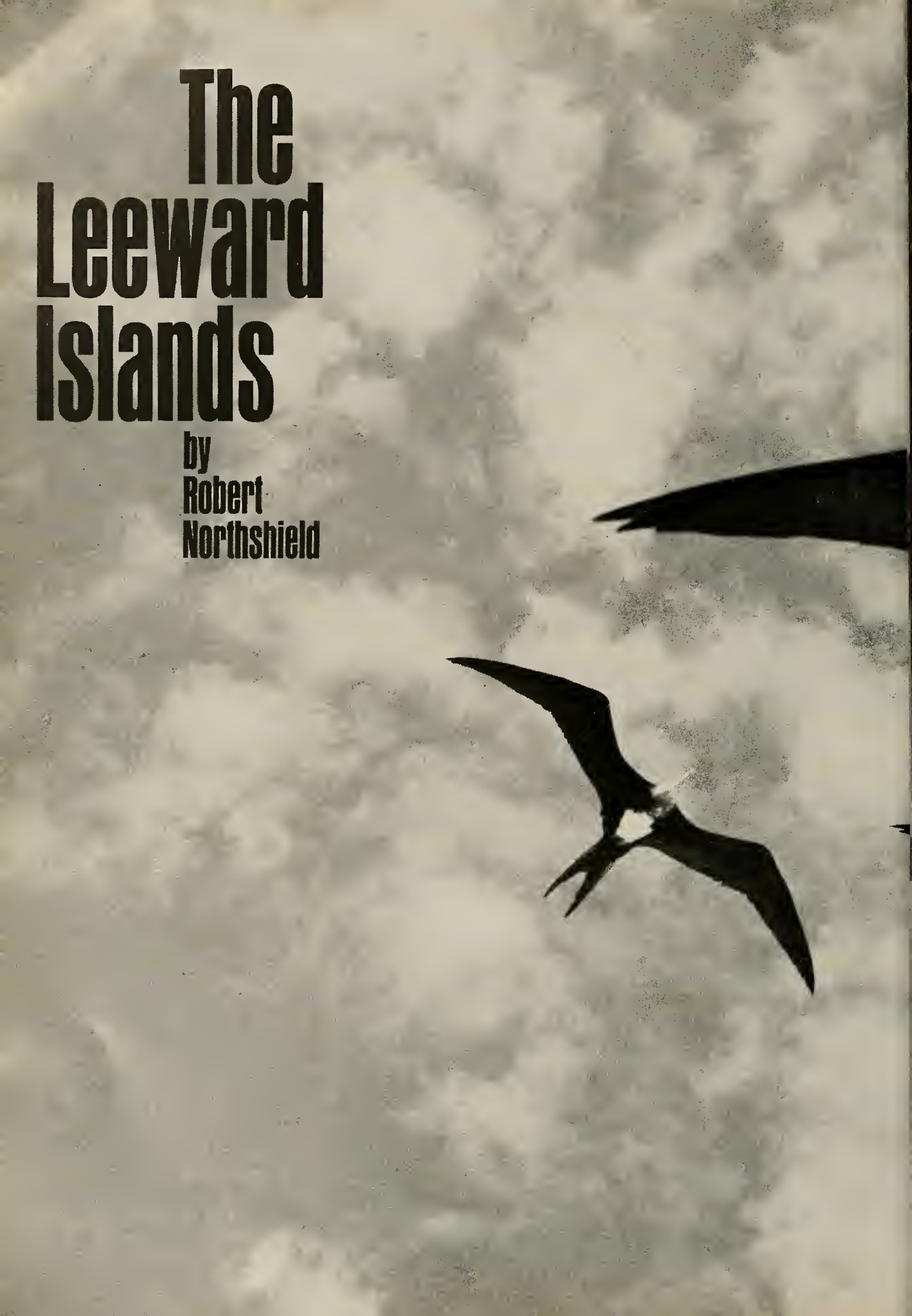
Lip plug, earplugs, penis sheath, hair style, cotton leg and arm bands, and body painting make up a symbolic language that expresses a wide range of information about social status, sex, and age. As a language, however, it does more than merely communicate this information from one individual to another: at a deeper level, it establishes a channel of communication *within* the individual between the social and biological aspects of his personality.

The social and psychological "message" of bodily adornment is coded and transmitted on an even more basic level by the colors used in body painting, and the symbolic associations of the parts of the body to which each color is applied. The colors of Tchikrin body painting are red (made from the seeds of the urucú plant), black (made from the juice of the genipa fruit), and, rarely, white (made from white clay), and these are used in determinate ways. Red is always applied on the extremities of the body—the forearms and hands, lower legs and feet, and the face. Black is always used on the trunk and upper parts of the limbs, as well as for the square cheek patches and borders along the shaved area of the forehead. The

Continued on page 70

The Leeward Islands

by
Robert
Northshield



Great Frigatebirds

There are few happy endings in the literature of conservation. The efforts at significant preservation of plant and animal species alike often result in only partial or questionable success: the redwoods, the Whooping Crane, the Ivory-billed Woodpecker, the California Condor. Wanton and willful or unknowing and uncaring, we have destroyed both creatures and habitat. Our moves to protect other species, it may be fairly said, are often token gestures, even afterthoughts.

But, on what may be the most remote bit of American landscape, there is a story of modest ecological success. It was written on a slim arc of tiny atolls that swing out more than a thousand miles northwest from the main Hawaiian Islands. These rocks and islets are called the Leeward Islands and comprise the Hawaiian Islands National Wildlife Refuge. The area is over 99 percent water, and is uninhabited by men except for eighteen Coast Guardsmen at a tiny station on French Frigate Shoals. There is an abundance of beauty and warmth here—and animals unafraid

Recovered from the depredations of plume hunters, many albatrosses now inhabit the Leewards. Two Black-footed Albatrosses, below, confront a green turtle on one of the tiny atolls.

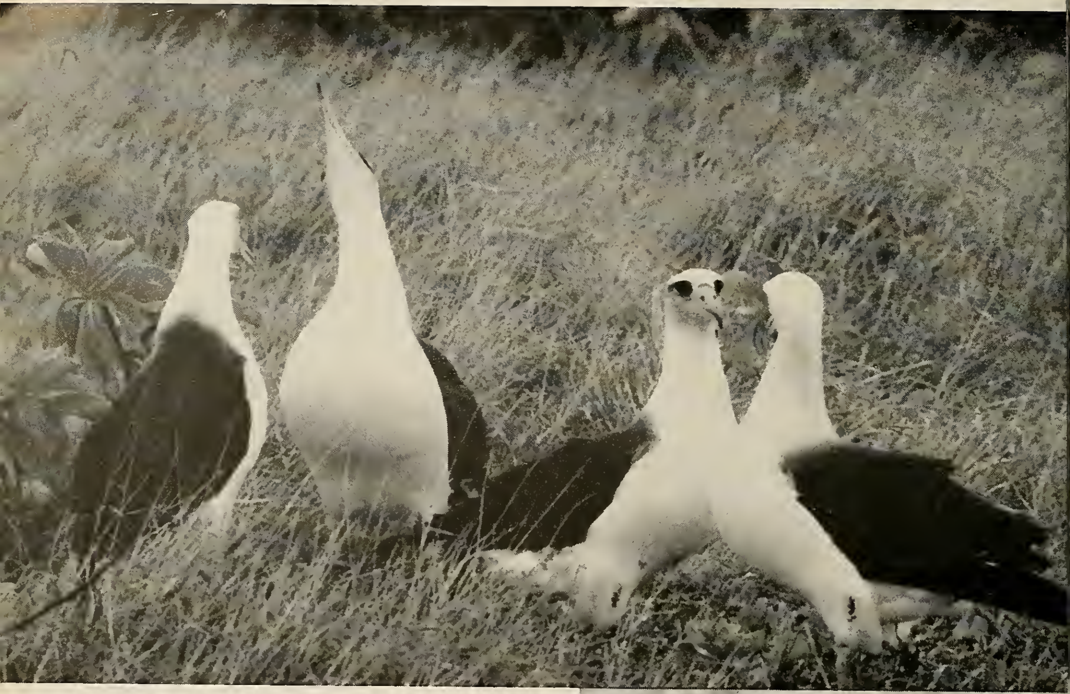
of the few men who visit. And there are birds, millions of birds.

The story of the Leeward Islands is, not one of an untouched paradise, but one of restoration. During the first two decades of the twentieth century, the depredations of feather hunters and fertilizer (guano) miners took a serious toll of the islands' bird life and drastically altered the islands' ecology. At that time, there was a ready market in much of the Western world for outlandish plumes on women's hats. Fashion demanded, and the hunters responded, coming to the Leewards to seek the plumage of the native birds, the albatross in particular. One entrepreneur recruited a band of Japanese workers, came to the islands and began harvesting whole wings to be used as millinery adornments.

In 1903, the naturalist William A. Bryan visited Laysan, the largest (at two square miles) of the Leeward Islands. His description glowed with the wonder of this "bird heaven." In 1911, he returned, after the feather hunters had come and killed and then had left the island to "harvest" elsewhere. He found a different scene:

"The slaughter wrought by the plume hunters is everywhere apparent. One of the work buildings used . . . as a storehouse by the poachers is still standing. With a side torn out and left open to the weather, it is still filled with thousands of pairs of albatross wings. Though weather-beaten and useless, they show how they were cut from the birds whose half-bleached skeletons lie in thousands of heaps scattered all over the island.

"This wholesale killing has had an appalling effect on the colony. No one can estimate the thousands, perhaps hundreds of thousands, of birds that have been wilfully sacrificed on Laysan to the whim of fashion and the lust of gain. It is conservative to say that fully one-half the number of birds of both species of albatross that were so abundant everywhere in 1903 have been killed. The colonies that remain are in a sadly decimated condition. Often a colony of a dozen or more birds will not have a single young.



Laysan, above, and Black-footed Albatrosses, below, perform nesting rituals. Red-footed Boobies, above right, nest in the low fleshy vegetation.

"Over a large part of the island, in some sections a hundred acres in a place, that 10 years ago was thickly inhabited by albatrosses, not a single bird remains, while heaps of the slain lie as mute testimony of the awful slaughter of these beautiful, harmless, and without doubt beneficial inhabitants of the high seas."

Alerted to the ravages of the plume trade, Theodore Roosevelt in 1909 issued a presidential order making the Leewards one of the early national wildlife refuges. That was a first step. But guano miners had imported rabbits to serve as a wild food source during mining operations. What vegetation there was on the chain was devoured by the multiplying rabbits. They moved into the burrows of nesting petrels and shearwaters, and flourished. Two expeditions were required to eliminate the rabbits, so that the birds could reclaim their nesting grounds.

Laysan, the most blighted island, was left bar-

ren of plants. And in the few years of commercial exploitation, three birds—the Laysan Rail, the Laysan Millerbird, and the Laysan Honeycreeper—had become extinct. The census of Laysan Teal showed only seven individuals. The native finch managed to hang on, barely.

Following removal of the rabbit population, the restoration of the islands proceeded more rapidly. There was nothing unusual in the methods used to promote recovery—the area was simply left alone. Men from the Department of the Interior's Fish and Wildlife Service remained on the atolls for a time. They patrolled the beaches. Sometimes they studied the birds. But most important, they merely allowed the birds to return to their homes on those almost imperceptible spots on the enormous map of the Pacific. Protection today remains rigid. Every visitor must have federal permission to set foot on the islands, and the area is carefully guarded against introduced animals and nonnative plants. The ecosystem is restoring itself, with the exception of the three lost species of birds, the Laysan Rail, Millerbird, and Honeycreeper.

A Brown Booby spreads its tail in alarm but stays on its nest as a human visitor approaches.

Now millions of albatrosses (both the Black-footed and the Laysan species are called "gooney birds") come to nearly all the islands to nest. From October to July the great birds hover about their nesting spots. The young fly out to sea with the adults in midsummer, and spend the next four years at sea. When they come back, they return to the spot where they were hatched. Continuing observation of banded birds reveals a sizable number nest within a yard of where they themselves were born.

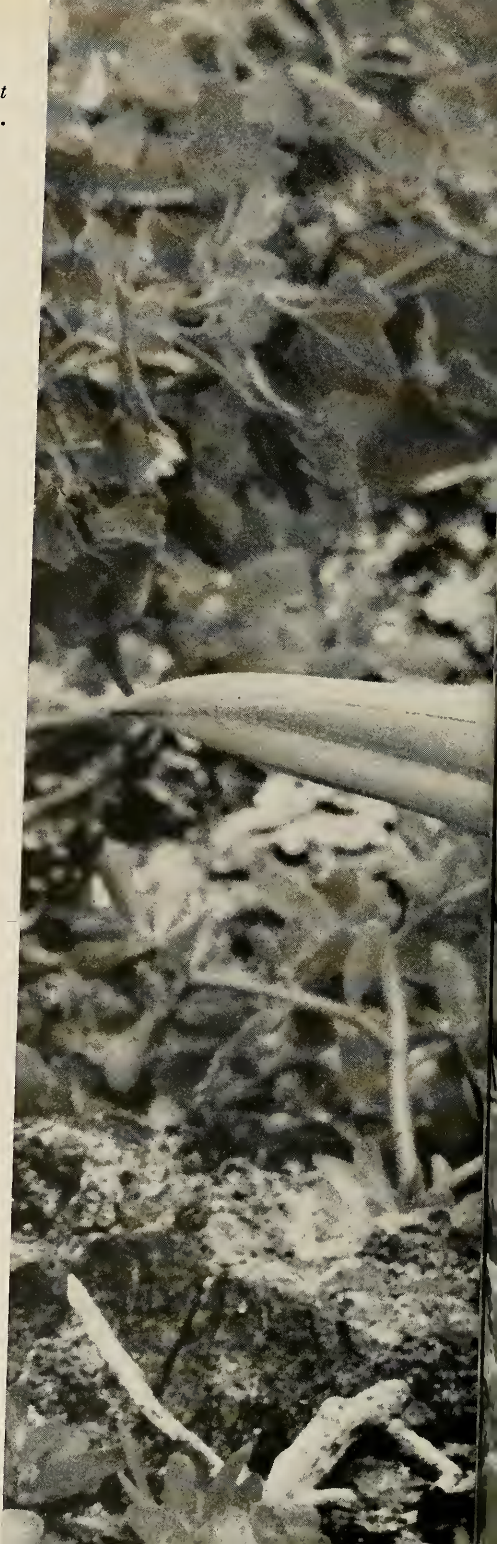
Mature albatrosses spend three months of each year soaring about the Pacific, rarely resting and seldom even flapping their magnificent wings. But during most of the other nine months, they inhabit the colonies of the Leewards.

While the gooneys are spectacular and even famous, they are not the most common of the birds on the refuge. Sooty Terns nest in mile-long colonies with birds resting wing to wing. In addition there are three kinds of boobies—Brown, Blue-faced, and Red-footed—nesting in large numbers. There are noddies and shearwaters and petrels. Great Frigatebirds, too, nest and swoop around many of the tiny islands, a spectacle rivaled only by the gorgeous Red-tailed Tropicbird.

The Leeward Islands are now under the guardianship of the Bureau of Sport Fisheries and Wildlife. Two busy men from the Bureau patrol and study the refuge. Two or three times a year, they put out from Honolulu aboard a Coast Guard buoy tender to visit their charges along the 1,100 mile chain of islands, putting ashore wherever the violent tides and winds permit.

Recovery continues, even though several of the islands' species are still rare. The islands' Nihoa Millerbird is an endangered species. So are the green turtle and the 1,500 Hawaiian monk seals that occur nowhere outside the waters of the Leeward chain. The Laysan Teal, though listed among the endangered species of the world, has made a fine comeback and now numbers about five hundred.

With continued protection, there is hope that the Leewards' other species will replenish themselves, moving from the edge of extinction to occupy a secure foothold among this windblown sprinkling of Pacific islands.



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Jumping Spiders

Continued from page 32

many of the tiny spiderlings disperse themselves over a wide area by "ballooning": they climb to the top of a rock or bush, emit a quantity of fine silk to serve as a "balloon," or "parachute," and then allow themselves to be wafted away by the wind. It takes only the faintest breeze or rising air current to lift and carry them great distances. Ballooning spiderlings have been known to land upon ships two hundred miles at sea.

As it matures, the spider undergoes several molts—from about four to eight—the larger species molting more times than the smaller ones. After the final molt the spider is fully grown, and only then is it ready for mating. After fulfilling this biological obligation the male lives for a short time; the female usually lives on until after the eggs have hatched.

One of the most interesting aspects of the spider's molting process is its regeneration of missing appendages. If a salticid loses a leg or two—a not infrequent calamity—in a hostile entanglement with another spider, a subsequent molt will restore the missing legs, although they may return somewhat smaller than normal. Incidentally, the loss of an appendage does not seem to detract from a salticid's jumping ability. Even if it loses both rear legs on the same side, it will merely take off at an odd angle but still hit its target precisely.

The life-span of a jumping spider (barring accidents and severe lack of nourishment) varies from species to species. Some live for only a season, most seem to live for about a year, and there are reports of so three-year-old individuals of the nus *Phidippus*, the largest saltic Another feature of the jumpers their striking coloration, which vites comparison of these creatu with the most beautiful of jewels.

The moist tropics contain t greatest number of jumping spide there also the colors are the m brilliant and diverse. We see th displaying every imaginable hu green and gold, copper and silv blue, red, yellow, black, and whi A single spider may wear as ma as five or six distinct and vi colors, and only seldom does t coloration seem to function as protective device, for the most la ishly decorated individuals para ostentatiously in surroundings th serve to distinguish, rather than co ceal them. A species found Guayana has been described as ha ing "dense black fur glistening wi metallic green, pink palpi and ro jaws." Thus ornamented, males a females of the same species c recognize each other at considera distances, which may explain t evolution of such elegant displays

It is the iridescence in the color some jumping spiders that is so u expected to those who see them f the first time. As light strikes t hairs and scales on their backs fro a certain angle, we might see only metallic gold, but from another ang the gold vanishes and we see inste a shining green or copper.

Several species, of course, do e ploy their color for camouflag These are generally duller except f

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City________________State________________Zip Code________________ e characteristic ornamentation on e foreparts of the males: but a ecies has been reported from istralia that is speckled black, iite, and pink to blend with the anite rocks upon which it lives.

Many species have improved their ances of survival by mimicry. The rcest enemies of jumping spiders em to be certain wasps and larger iders. Since these animals rarely tack ants, we discover many salti- ds mimicking ants almost perfectly body structure. color and move- ent. It often requires the closest rutiny to distinguish between them. iere are ant imitators in Florida id Mexico that even run in com- iny with the ants they mimic.

At least one salticid mimics the d. velvety cow-killer wasp in color- ion and mode of walking. It even arches around with its front legs ld over its head in imitation of the asp's antennae. Another species iitates a small blue beetle by hold- g its practically transparent front ir of legs tightly against the body id walking upon only six legs as ɔes the actual beetle.

Other salticids defend themselves om predators by inhabiting certain fensive plants. In Mexico a bril- ant red and black *Phidippus* lives most exclusively upon low, thistle- ke plants. At the approach of dan- er, the spider balls up and drops like stone to the base of the plant. There ie impenetrably thick thorns dis- ɔurage pursuit by the predator. thers live on the bull-horn acacia hich has hollow thorns infested y swarms of fierce ants. The ants do ot bother the spiders, but they rise i full force against other threaten- ig visitors.

The number of species of jumping piders can only be guessed at. In ie United States there are about iree hundred; in all the Americas ie species probably number into the iousands. In a limited area of the opics we might find as many as ɔrty or fifty different species in a ingle day, and in the tropics the hances seem excellent of finding itherto unknown or unrecorded rep- esentatives. Since each new one night well be more beautiful than ie last, or show a greater refinement f jumping habits, a naturalist is asily inspired to look for them with ie same enthusiasm that others have or hunting diamonds.

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Tchikrin

Continued from page 59

black face paintings, executed with painstaking care, are often covered immediately after they are finished with a heavy coat of red, which renders them almost invisible. The explanation for this peculiar practice lies in the symbolic values of the colors involved.

Red always connotes energy, health, and "quickness," both in the sense of swiftness and of heightened sensitivity (which the Kayapo conceive of as "quickness" or "lightness" of skin). Black, on the other hand, is associated with transitions between clearly defined states or categories, with "borderline" conditions or regions where normal clear-cut structures of ideas and rules of behavior are "blacked out."

It is interesting that the word for black, *tuk*, also means "dead," and is the adjective used for the zone of land just outside the village, which separates it from the completely wild forest and savanna country. The graveyard and the secluded camps used by groups going through "transitional" rites, such as initiation, are located in this interstitial area. Death itself is conceived of by the Tchikrin as a transitional phase between life and total extinction. The ghosts of the dead live on for one generation in the village of the dead, after which they "die" once more, this time passing into total oblivion.

White, which occurs only in relatively infrequent ceremonial decorations, is associated less with transition than with the pure, "terminal" state of complete transcendence of the normal social world. It is, for example, the color of ghosts. White clay is the food of ghosts, and the villages of the ghosts are always located near outcroppings of white clay or rocks.

Body painting for both ordinary social and ritual occasions seems to be a means of expressing heightened integration and participation in the social order as well as a means of heightening individual biological and psychological powers. Red is applied on the parts of the body most immediately associated with swiftness, agility, and sensory contact with the outside world (feet, hands, and face). This seems logical enough from what we have seen of the symbolic values of the color red. Black is used for the parts of the body most intimately associated with the individual's biological being, his inner self as contrasted with his faculties of relating to the world (the trunk, upper parts of the limbs, and certain areas of the head).

Why should black, which symbolizes the marginal, transitional, or imperfectly integrated aspects of the social order, be thus associated with the individual's presocial (biological) being in those situations where integration into society is being dramatized and reaffirmed?

To answer this question adequately we must start from an understanding of the symbolic significance of the skin in Kayapo culture. The skin, for the Kayapo, is the boundary of the individual on several levels of meaning. In the obvious physical sense, it separates the individual from the external environment, which includes other people. But in a more subtle sense, the skin symbolizes the boundary between two levels of the human personality: the lower level, based on presocial drives emanating from the individual's biological constitution, and the higher level of moral conscience and intellectual consciousness based on cultural principles derived from social sources outside the individual. More simply, this inner, psychological boundary corresponds to the boundary between the physical individual and his society.

The proper balance of relations between the levels of the individual's personality, like proper relations between individuals in society, depends in Kayapo thought on the right sort of communication taking place across these two correlated boundaries. They must be crossed in both directions, for society needs the biological energies of individuals, but it also needs to control them to prevent disruption and chaos. The individual subsists through his biological energies, but he needs the steadying influence of social values, cognitive categories, and moral principles or he will "go berserk" (a recognized condition in Kayapo, known as *aybanh*). Disease, death the breaking of certain taboos, and going berserk are all conceived a improper forms of eruption of th biological level of existence into th social, orderly level.

The interesting point for our purposes is that all of these "eruptions" are associated with disorders o treatments of the skin: sick people are painted red, dead people either red or black, taboo-breakers ge hives or other skin diseases, the skin of berserks becomes alternately overheated and then cold and insensitive etc. When black, the color associated with transition between the socia and asocial worlds, is painted on the skin of the central parts of the body it expresses the transcendence of the boundary between individual and society and thus reaffirms the mutua integration of the biological individual and the "body social."

It becomes easy to understand then, why the Tchikrin paint over the black designs of the face with red: They are concerned not so much with esthetic results as with a symbolic statement, in which both colors have complementary "messages" to transmit. The overpainting with red serves to energize, to charge with biological and psychic life-force, the sensory and intelligent part of the person whose socialization has been asserted by the black designs below.

Body painting at this general level of meaning really amounts to the imposition of a second, social "skin" on the naked biological skin of the individual. This second skin of culturally standardized patterns symbolically expresses the "socialization" of the human body—the subordination of the physical aspects of individual existence to common social values and behavior.

It would be misleading to lay too much emphasis on the superficial differences between Tchikrin body adornment and our own culture's elaborate array of clothing and hair styles, makeup, and jewelry. Among the Tchikrin, as among ourselves, the decoration of the surface of the body serves as a symbolic link between the "inner man" and some of his society's most important values.

e Cossums aren't trying to save the world. t a little piece of it.

er Davis is a friendly, dark-lle boy whose smile can light ntire room. But for most of ears, he hasn't had much to out.

er lives in Laurel Creek, an hian town of 200 people in y with a per capita income a year. Like most of the ople of Laurel Creek, Lester a three-room weatherboard long with his mother and nd nine brothers and sisters. ve no well, and of course no lumbing. So Lester's mother, carries all the family water the nearby creek.

ter's father, Ray, used to work coal mines, but since the played out" he's been unem-As Tressie admits, "It's aw-l going. We never could get od start before." They still 't have a "start" if it weren't Cossum family.

and Martha Cossum live in ban community of contem-homes. Looking out back you one of those large, above-ground plastic swimming pools. And you can see the beginnings of a redwood deck around the pool, which Ed and his two children, Bill and Carol, are g themselves.

is a systems analyst. He most of his day thinking third generation computers. ately, Ed and Martha also about this generation of chil-ving in Appalachia.

rough Save The Children tion, the Cossums are helping and his family. They contrib-5 a month. Though it's not a money, the Cossums could ly have done a lot of other with it.

e Cossums' contribution will de available to the Davises a gift, or charity, but as a loan. erest-free loan which Lester's can borrow to begin a self-roject.

r. Davis already has a project d. He plans to use the Cossums' money to buy and feed two cows, then sell the calves as they come along. As Mr. Davis says, "A man likes to find ways to take care of his own family."

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The Engineerin Mentality

by Harold Gilliam

AMERICA THE RAPED, by Gene Marine
Simon and Schuster, $5.95; 312 pp.

There is never any doubt about who wears the black hats. Right at the beginning Gene Marine makes it clear:

"The new rapists are loose upon the land. Theirs, still, are the vicious, violent, laissez-faire techniques of the turn of the century. . . . They are dedicated, single-minded men. And when they talk —which is as rarely as they can manage—theirs is the language of fanatics.

"They are called Engineers. . . . They commit rape with bulldozers."

In case this seems a little melodramatic, Marine concedes that there are some "good engineers." But he is talking about the "engineering mentality" —all the people who pursue single-purpose projects with single-minded zeal and ignore the effects on the rest of the environment.

They "are not only straining to fill in the Grand Canyon and to dam the last wild stretch of the Missouri, to wall off the rich estuaries of Long Island and to cover the Great Swamp with asphalt. They are in every section of every state, ripping, tearing, building, changing."

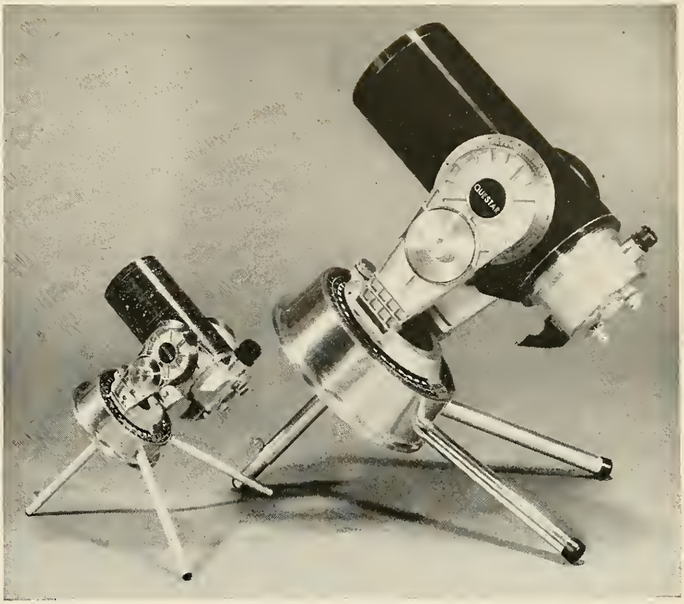
There is no dearth of examples. Marine describes the Army Corps of Engineers' canal that threatens to murder the Everglades, Kennecott Copper's projected open-pit mine in the heart of the Glacier Peak Wilderness Area in the Northwest, Consolidated Edison's plans to take apart Storm King Mountain on the Hudson, the fouling of Lake Erie and other American waters, the Corps of Engineers' scheme to submerge a good part of Alaska with the Rampart dam, the Bureau of Reclamation's designs for damming the Grand Canyon, the proposal to pave over the Great Swamp for another New York airport—plus briefer stories of innum-

ble, less-known examples of engi-
ring rapine and pillage throughout
land.

'ossibly Marine is a little hard on
Engineers. Maybe scapegoats are
essary to dramatize the point, but it
uld be remembered that the Corps
Engineers, the Bureau of Reclama-
ı, and state highway engineers act
ler laws of Congress and the legis-
ıres, all presumably elected by the
ple. Perhaps the blame should be a
e more evenly distributed.

3ut there is far more to this book
n assessments of blame. Marine's
untainous research has turned up
ne choice items. For example, he has
arthed an impressive Duke Univer-
study of the Corps of Engineers'
t-benefit formula, which is used to
ermine whether or not a project is
nomically feasible. A Duke econo-
t concluded that under alternate
thods of calculating costs and bene-
nearly half of the projects studied
ıld not have been justified—and the
payers would have been saved more
n $1 billion.

)ccasionally Marine takes on the
ıservationists. He thinks they often
to recognize that some engineering
ıctures are necessary. ("There is no
d foolishly to fight every work of
n. . . .") He believes that their hope
desalinization rather than dams is
sory. He says their arguments for
derness too often use snobbish-
ınding appeals to preserve "quality
as" for the select and hardy few.
d he scores them for talking es-
tics rather than ecology. Arguments
out preserving natural beauty, he
s, too often bog down in purely sub-
tive estimates as to what is beauti-
, and in unwinnable controversies
out whether beauty is as important
power plants or highways or mer-
ıntable lumber.



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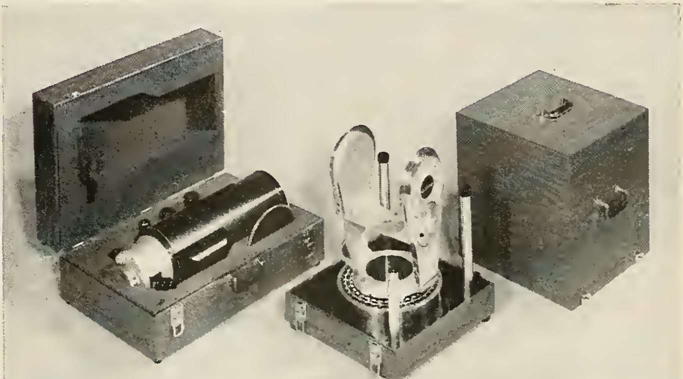

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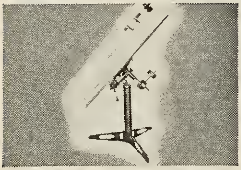

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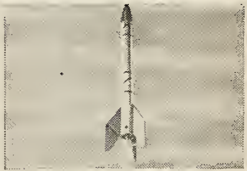

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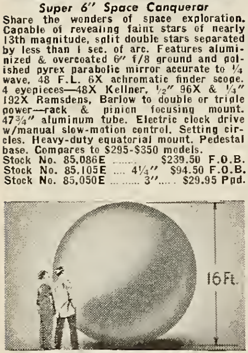

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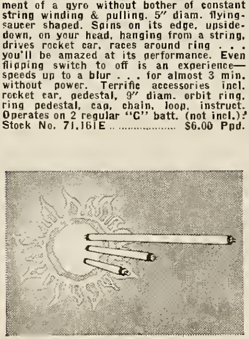

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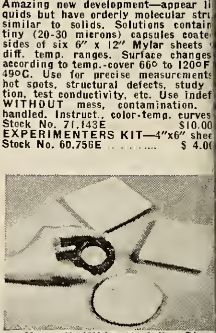

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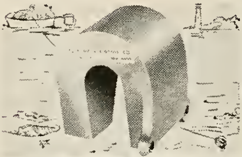

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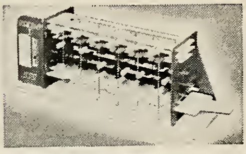

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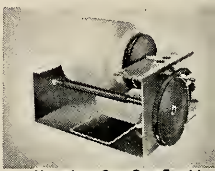

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e ultimate argument for preserva- he maintains, is scientific. It con- , "the conservation of genetic in- ation—the idea that we ought to every species of animal or plant , in its own ecosystem, because we no way of knowing what char- istics of what animal or plant or obe may some day prove to be in way valuable": for example, as ces of antibiotics, medicines, s, natural pesticides, industrial materials, foodstuffs.

telling point, yet the ecological ment also has limitations. It may well for the Everglades, but it d be hard to prove that every ral area worth saving has a unique . In many cases the arguments be not only ecological but es- c, educational, and recreational. conservation battle, it is well not ly on any single type of ammuni-

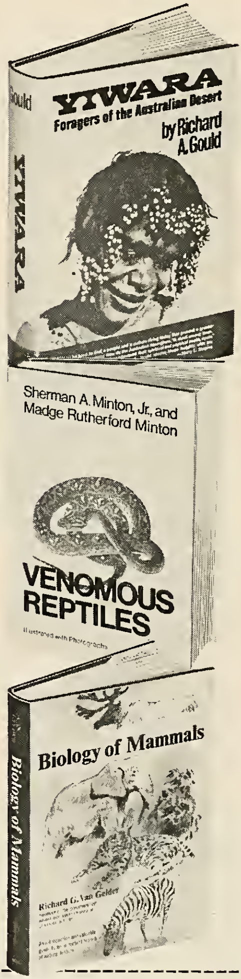
iis book originated in a series of les for *Ramparts* magazine, and it rs the usual drawbacks of journal- writing which leans heavily on spaper items and other secondary ces. There are inevitably some er- of fact as well as occasional mis- ing and outdated statements. San icisco Bay, for example, is not 40 ent filled (the figure is about 14 ent). The Bay Conservation and elopment Commission's plan for bay is not disliked by everyone Engineers and profiteers"; con- ation groups have been solidly be- it. Stewart Udall did not open the onal parks and wildlife refuges to eral and oil explorations.

ut despite these aberrations, the its Marine is making in each case largely valid: San Francisco Bay indeed be 40 percent filled if there no controls; the Bay Plan does weaknesses; and even the best rnment officials (like the best ers) make some mistakes.

he general thrust of this book is erful and vital. Its urgent message ritten in highly readable, anecdotal e. Its lively notes offer an invalu- bibliography for conservationists. ine raises many points that need to onsidered far more widely among ericans concerned with their de- orating environment. For instance, takes up a proposal made a few s ago by ecologist Raymond Das- n. He suggests that the best way to d the ecological damage wrought new airports, new freeways, and dams is, not to try to mitigate their act, but to avoid building them.

uppose Los Angeles, for example, n't get any additional water. "Peo- will not go to Los Angeles, and e of the people who are there will e. Is that bad?"

The wondrous ways of man and beast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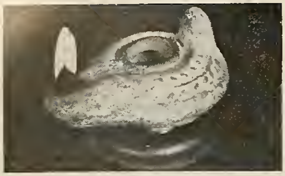

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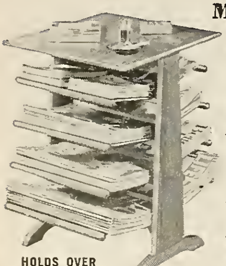

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I wonder if Marine would apply the same procrustean method to his own community in the San Francisco Bay area. Perhaps he would. Yet he notes that drought-caused water restrictions have not driven many people out of New York City. It seems doubtful that anything short of severe and prolonged hardship, which invariably falls on those least able to bear it, is going to stop people from moving to Los Angeles. But the point is debatable and is one of the many provocative ideas raised here.

In *God's Own Junkyard*, an earlier book in this style, Peter Blake admitted: "This book is not written in anger. It is written in fury." This, too, is a furious book, with all the virtues and weaknesses of that genre. Other recent books in this line have been Robert and Leona Train Rienow's *Moment in the Sun*, William Bronson's *How to Kill a Golden State*, and Paul Ehrlich's *The Population Bomb*. Dasmann's *The Destruction of California* and George Stewart's *Not So Rich As You Think*, while more sad or sardonic than furious, are essentially in the same tradition. The line is an old and honorable one, tracing its roots back to Lincoln Steffens and Upton Sinclair—and maybe even Tom Paine.

I am tempted to fall back on the old reviewer's cliché and say that this book should be read by every thinking American. It should, but it won't be, and the reasons are significant. We are all bombarded daily by threats, warnings, and alarms from every direction. The mail is deluged with urgent messages to write the President, congressmen, governors, and legislators on dozens of subjects, all of which are vital, urgent, and explosive—Vietnam, Biafra, ABM, CBW, violence on the campuses, crime in the streets, demands from the ghettos, inflation, pollution, and revolution.

Newsstands and bookstores overflow with writings that point out solemn problems and intolerable evils. Consequently, the negative approach has serious handicaps. (Unfortunately the title of this book alone may put many people off.) The multiple crises are so overwhelming that new declarations of evil are shrugged off. It may be that what we most need at this point in our history are not merely more threats but more hope, more encouragement, more understanding that success is possible, that conservation and environmental victories are achievable. Actually a large proportion of the engineering atrocities cited by Marine are projects that have not been accomplished—at least not yet—largely because of the successful battles waged by conservationists.

The success of David Brower's Sierra Club pictorial books indicates that the conservation message can effectively communicated in an affirm tive context. Fortunately, the new p perback editions are getting these s perb books to wider audiences.

Nevertheless, there will always be need for the pamphleteer, for the ang man, for the furious book, for t diatribe, and the jeremiad. We ne Gene Marines to popularize the fin ings of the scientists and to cry alar like environmental Paul Reveres. Ev if only a few people listen, they c pass the word along.

Harold Gilliam writes on environme tal subjects for The San Francis Chronicle. *His most recent books a* The Natural World of San Francis *and* Between the Devil and the De Blue Bay.

Men in Groups, by Lionel Tig *Random House, $6.95; 254 pp.*

In spite of the author's rather den style and an engagingly idiosy cratic addiction to "op. cit.," a "ibid.," this is an interesting book which the author attempts to show th the tendency of males to group t gether—male bonding—may depe upon or actually be a function of a bi logically transmitted, as well as a s cially learned, component of the ma life cycle. Mr. Tiger wants to kno why males treat males differently fro females, whether it may be that t same "natural" principles that gove differences in behavior between ma and female baboons, between turtl and geese, and between puppies a dogs, also govern the behavior of h man beings.

Mr. Tiger presents the hypothes that a "human male bonding pr pensity may have been a hominid inhe itance from the primates." Since m is a primate, Mr. Tiger means the no human primates. He further hypoth cates that "male bonds are of the sa biological order for defensive foo gathering, and social-order-maint nance purposes as the male-fema bond is for reproductive purposes "Archaeologists," he asserts, "suppo the contention that *strategic violen* [italics mine] in association with mea eating and hunting constituted an i portant behavioral specialization a advantage of creatures early in huma life." Mr. Tiger is consistent in h usage of this term, for he defines it physical coercive force, and he scarce means this in the passage just quote Was man coercive or aggressive towa the plants he consumed before he b came an omnivore? Mr. Tiger does n tell us. Are women violent or aggressi

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or something else when they compete with each other at drapery sales?

The evidence is good for the proposition "that specialization for hunting widened the gap between the *behaviour* of males and females," making cooperative hunters of the males and better mothers of the females. Mr. Tiger's puzzlement as to why sociability exists in animals might have been resolved by looking into such books as Allee's *Cooperation among Animals* (1951), and Tinbergen's *Social Behaviour in Animals* (1965), not to mention numerous other works.

Not infrequently Mr. Tiger gets badly derailed, as for example when he says that "The changes in women's rights were effected largely by men." As the Duke of Wellington remarked on a famous occasion, "if, sir, you believe that, you will believe anything!" "Perhaps females," the author writes, "possess the 'releaser' which stimulates people to follow them mainly when they embody or share the 'charisma' of dominance of a closely related male." Perhaps. Then, again, perhaps not.

I am running out of space, so let me say this: I believe that Mr. Tiger is fundamentally wrong in his thesis and in his argument. But whether that be so or not, and however wrongheaded he may be, he has written a book that, like Otto Weininger's wrongheaded book of seventy years ago, *Sex and Character*, will serve admirably as a whetstone upon which the reader and the student of human nature may sharpen his wits. Ultimately, what is important about a theory is not that it prove either right or wrong, but that it be fruitful. I rather suspect that Mr. Tiger's book will prove to have a reactionary effect.

Ashley Montagu
Anthropologist and Author

Pre-Columbian American Religions, by Walter Krickeberg, Hermann Trimborn, Werner Müller, and Otto Zerries. *Holt, Rinehart & Winston, Inc., $8.95; 365 pp., illus.*

This is not only a volume on religion; it is a veritable book of revelations. The Rocky Mountains are in the wrong place, all tribes north of the Canadian border are savages, the Pecos River is now the Rio Grande, and a long, sinuous waterway connects the Gulf of California and the Gulf of Mexico (see Map 3 in the book for confirmation of all these scientific discoveries). Anyway, the map looks as if it were put together by a sixteenth-century Milanese cartographer. The enlightenment the book provides on North, Middle, and South American Indian religion is just about as advanced. While the chapter on the ethnological data regarding

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SUMMARY: For ten years we have been organizing trips to investigate the Natural History of the world. The program is summarized below; see opposite column for the schedule for coming months. Tours are usually set up in a regional connecting series, so that persons with sufficient time may stay for more than one and save air fare.

— NORTH AMERICA —

The North America program consists of 17 tours, carefully arranged to provide a sampling of the Natural History of the continent. A popular winter trip is Florida; early spring tours are run in Arizona and Texas (the Whooping Cranes and stress on wildflowers). Two 3-week tours, based on geology and emphasizing ecology, go "north with spring" in the Sierras and Cascades. A pair of fall-color tours covers the eastern seaboard and mountains, alternating yearly with a pair of "Basin & Range" tours which start at Nunavik, Northwest Territory, and end in Canyonlands National Park, Utah.

Alaska is covered in a series of 3 two-week trips, from the Inside Passage to the Aleutians, Pribilofs and Point Barrow on the Arctic. Newfoundland Labrador and Arctic Canada tours complete the continental coverage.

— MIDDLE AMERICA —

Mexico and Central America, where bird life overshadows all other features, are well covered. Mexico is divided into 7 routes, from Baja California to Yucatan. Three routes in Central America and 3 in the West Indies reach all regions of significance except Cuba.

— SOUTH AMERICA —

Colombia, the world's top country for bird species, is visited twice a year. A series of 5 trips counter-clockwise around South America is featured in "odd" years (1971 etc.) during the Southern Hemisphere spring. Peru and Venezuela are reached annually, and the Galapagos are visited frequently in coordination with Lindblad Travel.

— EUROPE —

There are 12 tours to choose from each year in Europe, and many fine combinations are possible. A series of 3 trips goes north with spring from the Mediterranean to North Cape. Another series of 3 starts at Lisbon and works eastward to the Balkans and Russia, followed by Siberia, Mongolia and on around the world. A fine annual tour is devoted to Britain, and there are 3 Iceland trips a year, including the center and the rarely visited northeast coast.

— ASIA —

Japan and Siberia are visited annually, and a popular series of 5 tours stretches across South Asia every 3rd year (1971, 1974, etc.). China is still out of bounds, but most other Asia regions of significance to naturalists are covered.

— AFRICA —

Africa has been divided into 7 Natural History routes, at least 4 of which are covered each year. Popular East Africa is included, of course, as well as the North Africa coast, Madagascar, the Indian Ocean and other regions.

— SOUTH PACIFIC —

This is one of our top features, with exceptional leadership and captivating itineraries. A full circuit of the Pacific is made in the Southern Hemisphere spring of "even" years (1970, 1972, etc.) from Hawaii and Melanesia to New Guinea, Australia and New Zealand. Eastern Australia and New Zealand are visited annually.

The above program represents the astounding world coverage now in operation; about 50 of the tours are offered each year. And we still seem not to have lost the friendly, untouristy personal touch which we think you'll like.

CROWDER NATURE TOURS
BOX 222-a
HARPERS FERRY, W. VA. 25425

North American Indian religions is understandably one of the longest (because that is the part of the New World about which we have the best information), not even a *page* is devoted to the archeological evidence with regard to the development of native religion in North America, although over a third of the book concerns the archeological background of the Middle American and Andean civilizations. The utterly ridiculous justification for this—made by the editor, Walter Krickeberg—is that the archeology of North America is relatively worthless for the purpose. Bull feathers! What about serpent mounds, ceremonial burials, petroglyphs, the evolution of the kiva, etc., etc., etc.? There is nothing in this book that the specialist could not find out more accurately somewhere else. The same is true for the book's relevance to the layman, with the addition that the latter would also find it dull and confusing.

Perhaps we can pardon the original German edition of the book, published in 1961. But what seems inexcusable is for an American publisher to issue, eight years later, with the claim that it is a "fascinating and comprehensive study," this compendium of inadequate, erroneous, confused, and often out-of-date material for an American audience that is relatively sophisticated about the American Indian. But perhaps I am being too hard. The dust jacket does say ". . . it is easy to forget that one is reading 'a standard work.' " And with this I completely agree.

MICHAEL J. HARNER
Columbia University

PRE-COLUMBIAN ART OF MEXICO AND CENTRAL AMERICA, by Hasso Von Winning. *Harry N. Abrams, Inc., $35.00; 388 pp., illus.*

Popular interest in pre-Columbian archeology can be traced back in this country as far as the 1840's. In that decade the New Yorker John Lloyd Stephens and his gifted artist-traveling companion Frederick Catherwood published the first "best seller" in this field—the superbly illustrated report on their travels in Central America and their exploration of the Maya ruins they encountered there. The interest aroused by these reports, as well as by many later accounts, was primarily archeological. Often it was mixed with a fair amount of fanciful, science-fiction speculation about such things as the Lost Continent of Mu, from whence it was supposed that the ancient Maya must have obtained the knowledge that enabled them to build their temple cities. The Indian objects

CROWDER NATURE TOURS

SCHEDULE: Listed below are starting dates for the next 15 months or so. Space permits only a brief mention of each tour, and one should by all means have the "Tour Catalog" with thumbnail sketches of each trip, as well as subsequent detailed itineraries. North America tours are 2 weeks each, others 3 weeks, unless otherwise noted.

— 1969 —

SOUTH AMERICA (5 tours)
The 3-week tours originate in Miami and may be taken separately or in series. Departure dates: Brazil, Oct. 18; Guianas-Venezuela, Nov. 8.

SOUTH WITH AUTUMN (2 tours)
Geology and ecology of the eastern U.S.A., following the wave of fall color southward. Northeast Coast tour meets at Bangor Sep. 19; Southeast Coast tour at Harpers Ferry Oct. 10. Leader: Geologist Isabella Coons, with many assisting leaders along the way.

AUSTRALIA — N. Z. (3 tours)
Added by request, Australia tour leaves L.A. Oct. 25; New Zealand Nov. 15; N.Z. West Coast (2 wks) Dec. 6.

XMAS PARTY—BERMUDA
Each year a few of us gather for Xmas or the few days after at convenient but unusual places. This year it's Bermuda.

— 1970 —

MIDDLE AMERICA (4 tours)
Following the Florida Tour (from Tallahassee Jan. 10): Yucatan, from Miami Jan. 24; Panama, Feb. 7; Colombia, Feb. 21.

TEXAS — MEXICO (5 tours)
Texas from Corpus Christi March 7; Taxco, Holy Week special; then Mexico West & East Coast.

PACIFIC COAST (7 tours)
Baja California camping, from Nogales Mar. 28; Arizona, from Tucson Apr. 25; Sierras, from San Diego May 9; Cascades, from Klamath Falls, May 20; followed by Alaska South, North and Outposts. Remarkable tropics-to-Arctic coverage of spring in Western North America.

EUROPE (12 tours)
Too much of a program to list here; by all means send for detailed brochure. Norway, Iceland, Russia and Siberia especially recommended. Twelve tours, extending through May, June, July.

EUROPE SEMINAR
New beginning this year: a week's seminar on Basic Ornithology and the Natural History of Europe. In the lovely Lake District of England, centering at Ruskin's home on Coniston Water. Joint project with World Nature Club. Last week of May, tying in nicely with European trips.

CENTRAL AMERICA
Summer program in rainy season when birds are on territory. July and August, 3 tours; Chiapas, Panama, Yucatan.

AFRICA (3 tours)
South and East Africa and Madagascar; three tours in July/September. Excellent leadership.

SOUTH AMERICA (4 tours)
Venezuela, Aug. 15; Colombia, Sep. 5; Ecuador/Peru, Sep. 26; Chile/Tierra del Fuego, October 24. Also Galapagos and Antarctica.

SOUTH PACIFIC (8 tours)
This is the year of full South Pacific coverage. Melanesia, Aug. 15 from Samoa; New Guinea, Sep. 5 from Rabaul; Western Australia, Oct. 3 from Perth; Australia East, Oct. 24 from the Barrier Reef at Cairns; New Zealand, Nov. 14 from Auckland; N.Z. West Coast, Dec. 5. Also special tours of New Guinea/West Irian north coast, and Western Australia wildflowers.

— 1971 —

ASIA (5 tours)
An extraordinary series, perhaps the most exciting we've ever arranged. Departure dates: Indonesia, Jan. 9; Melanesia, Jan. 30; Thailand, Feb. 20; Ceylon-India, Mar. 13; Himalayas, Apr. 3. Leaders, Crowder and Asia experts.

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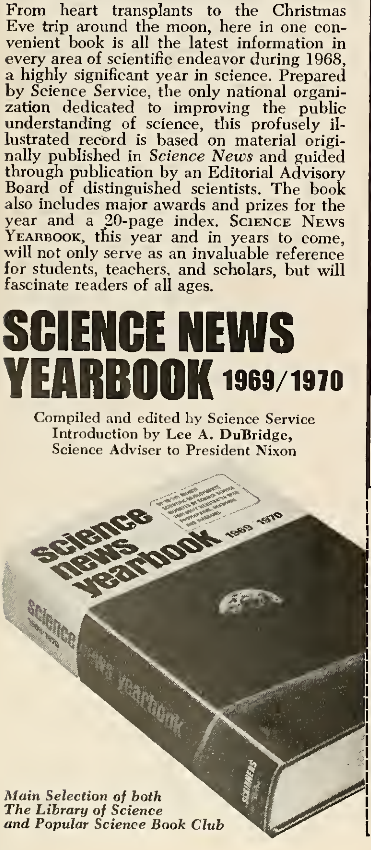
SCIENCE NEWS YEARBOOK 1969/1970

Compiled and edited by Science Service
Introduction by Lee A. DuBridge,
Science Adviser to President Nixon



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unearthed from time to time duri this period were occasionally broug back by explorers and travelers as c rious specimens and deposited, t gether with rock and mineral sampl fossils, and stuffed hunting trophies, early collections and museums devot to natural wonders. As works of a however, they were held in low estee It was generally assumed that, like a the arts outside of our tradition, th were only crude efforts to approach t perfection achieved by the Greeks the fifth century B.C., and rediscover in the Renaissance. They were consi ered primitive, much as baby talk is child's primitive attempt to imita adult speech. In our own time this at tude began to change, largely as a resu of the eye-opening impact of mode art. In the early years of this centu certain pioneering avant-garde artis most notably Picasso and Derain, e plored areas of form and percepti that were remarkably parallel to Af can tribal arts. As a result of their ov development these artists began recognize as genuine works of art dan masks and other ritual paraphernali which until then had been regard only as curiosities. It was the begi ning of an ongoing esthetic dialog between what we continue to call prir itive art and the work of moder artists. As the impact of modern a influenced and formed the esthetic pe ception of our own generation, mo and more individuals responded to tl visual excitement of primitive art. Ar ists' studios began to be filled wi it, and from there the taste for suc objects spread to private collectors an eventually art museums.

The collecting of African art bega in Europe in the 'teens and twenties this century when returning official traders and missionaries brought bac tribal "curios" to the capitals of cou tries with African colonies. The collec ing of Mexican and Middle America pre-Columbian art began a little late and was centered primarily in Mexic and California. Again artists led th way. Diego Rivera formed a large an important collection during the 1930 and 40's, as did Miguel Covarrubia a noted artist who became a leadin writer and authority in this field. I California Mr. and Mrs. Walter Aren berg formed the first important pr vate collection of pre-Columbian a in this country, now housed in th Philadelphia Museum of Art.

The Arensberg collection was assem bled with the help of the first dealer i this country to specialize in this field the late Earl Stendahl of Los Angeles His son and associate Alfred Stendah selected the close to 600 pictures in thi splendid book on pre-Columbian art for which Hasso Von Winning wrot the text and notes.

TREASURE TOURS WINTER PROGRAM

1. DECEMBER—December 15th, 1969 to January 5th, 1970. West and Central Africa. A Field Trip in African Art and Ethnology in Mali, Dahomey and North Cameroun, with short sojourns on the Ivory Coast and in Chad. Led by Dr. Marshall W. Mount of New York, an authority on the subjects and the countries. Safari of the Dogon villages on the Bandiagara Plateau of Mali and of the Kirdi areas north of Maroua in Cameroun. A unique opportunity for those interested in African art and ethnology, extraordinary for photographers. From New York US$ 1895.00—20 participants.
2. JANUARY—January 26th to February 16th, 1970. Chad, The Heart of Africa. Peoples and wildlife of Central Africa in the Republic of Chad. An expedition for the adventurous, led by a British explorer familiar with the Chad. From New York US$ 2375.00 — 12 members.
3. FEBRUARY — February 6th to March 5th, 1970. India, Nepal, Ceylon. Peoples, traditional culture, dances, festivals and art of 3 different civilizations. Led by a noted Indian ethnographer with expert knowledge of the areas on the itinerary. Local co-leaders. From New York US$ 1975.00—24 participants.
4. MARCH — March 1st to 28th, 1970. Tigerwatching in India. Photographic Shikari in Indian wildlife sanctuaries. Wildlife photography with accent on tigers. Led by Mr. M. A. Badshah of Madras, noted Indian wildlife officer and nature photographer. From New York US$ 1993.00—15 participants.

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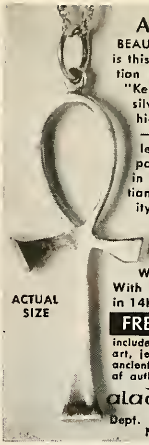
The book is in happy contrast to other recent volumes that reflected the immense growth of interest in this field, but too often reproduced again and again the same relatively few famous pieces easily accessible to photographers in major museums. This book concentrates instead on previously unpublished examples. In addition it focuses on four major culture areas usually slighted by other studies: the west coast of Mexico, the Gulf Coast area of Veracruz, the Maya, and the gold-working cultures of Panama and Costa Rica. It is precisely from these four areas that most pre-Columbian material has become available in our time. The book thus provides readers with an unequalled reference to important and authentic examples of the kind of object they are most likely to encounter personally, in private collections, and among the new acquisitions of museums.

The book also brings to mind André Malraux's concept of modern pictorial art books as "museums without walls." In this sense, this volume is an idealized collection without walls, an unequalled assembly of objects that have appeared during recent years, brought together between the covers of this lavishly produced volume. The history of taste in this field is also documented. Early interest during the 1940's and early 50's centered heavily on the highly expressive, sometimes grotesque clay figurines of the west coast of Mexico from the area of Nayarit, Colima, and Jalisco, a region formerly called Tarascan. With increasing exposure to pre-Columbian art came a more sophisticated and developed awareness of the cultures of the Classic Period, typified by the enthusiasm for the clay figurines of the "Smiling Head" complex found at Las Remojadas in central Veracruz during the mid-50's. Later the continuing refinement of insight led to greatly heightened appreciation of the art of the early pre-Classic period, that of the Olmecs and of related sites such as their outposts at Tlatilco and Las Bocas. The highly complex, hieratic art of the Classic Maya was probably intended originally to be understood only by initiates of the ruling and priestly class. It is therefore not unnatural that wide contemporary appreciation of this rich culture had to await the broadened sophistication of taste that came about only after prolonged exposure to more easily accessible and less-demanding pre-Columbian art styles.

The introductory text to each section traces the origin and spread of the various cultures. Each illustration is flanked by a brief caption. Longer and, to the interested reader, highly interesting and informative descriptions of each object are grouped separately



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on buff-colored pages preceding each section. It is the one detail for which this handsome book may be faulted. Paging back and hunting for the full description of each object that strikes the reader's eye is discouraging, tedious. and time-consuming work, leading the reader to regret that captions and pictures are not printed next to each other.

ANDRE EMMERICH
André Emmerich Gallery

TOO MANY: A STUDY OF EARTH'S BIOLOGICAL LIMITATIONS, by Georg Borgstrom. *The Macmillan Company, $7.95; 368 pp., illus.*

Perhaps the most dangerous people today are the myopic "experts" who claim to see ways in which technology can increase the carrying capacity of our planet to provide for one or more doublings of the human population. Professor Borgstrom is an expert in food science who does not suffer from myopia. He does not think (as one demographer recently told me) that the nitrogen cycle is a figment of biologists' imaginations. He does not share, with a colleague in food science, the view that we can "get along without food from the sea." He does not confuse the introduction of a few strains of high-yielding grain in the underdeveloped countries with an agricultural revolution offering fundamental solutions to their problems of undernutrition and malnutrition. He *does* understand the critical relationship of water to feed production and processing, and the appalling trends in the hydrological cycle of the earth. He does understand the central role of protein supplies in the world food crisis. He does understand the rapacious "concealed colonialism" with which the developed nations of the world continue to loot the edible and inedible resources of the hungry nations. And, Borgstrom sees clearly that man will have to work out his destiny, if any, through cooperation with nature, rather than through futile attempts to fight her.

Too Many is a thorough analysis for the layman of the factors that limit the global production of human food. It starts by commenting on the common use of words such as *limitless*, *inexhaustible*, and *boundless* to describe the earth's resources, and near the end concludes that the world "has only one true surplus, man himself." The meat of the book is devoted to showing why "we have lost the race between the baby crop and the grain crop," and to revealing why our losses are not going to be made good by increasing the food supply. The extent and relationship of arable land to dwindling forest reserves

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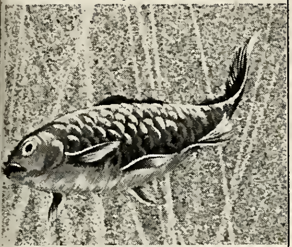

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is discussed in detail. So is the role of water in general and irrigation in particular in agriculture. The possibilities for supplementing the human diet with synthetic or other novel foods are explained, as are, briefly, some of the ecological effects of agricultural activities. An especially interesting chapter is devoted to the role of water in international politics, a discussion that adds credence to the growing consensus that population growth is hurrying us down the road towards thermonuclear Armageddon.

I wish that Borgstrom had gathered in one place a specific refutation of the "green revolution" propaganda that the agriculturalists have deluged us with lately. The material is largely there, but it is scattered. Equally, a more detailed analysis of the economics of desalinization would have helped those who might be tempted to think of it as a panacea. But these are minor quibbles. *Too Many* is an immensely important book written by a scientist who is clearly saddened by the state to which man has descended and angered by those who, through ignorance or greed, would keep him there. It should be read by every literate human being.

PAUL EHRLICH
Stanford University

PREHISTORIC EUROPE, by Philip Van Doren Stern. *W. W. Norton & Co., Inc., $10.00; 383 pp., illus.*

Archeological evidence suggests that the first Europeans were immigrants from Africa, pioneer hunters who made their way across a less arid Sahara, probably through Israel and across the Dardanelles. We do not know why they left Africa, the homeland of their ancestors for at least three million years, or when. But one of their original campsites, a cave in a valley near Marseilles that contains the earliest known traces of fire, is believed to be about 750,000 years old.

Prehistoric Europe is an account of the evolutionary process that transformed these people—pygmy-sized individuals with heavy brow ridges, massive jaws and sloping foreheads—into the citizens of classical Greece, where "human beings had gone as far as they are ever likely to go." Philip Stern has the strengths and weaknesses of other writers who are fascinated by the past and experienced in their craft, but inexperienced in the ways of science and scientific investigators. He combines an ability to present technical advances clearly and dramatically with a tendency to accept theories that no longer stand up in light of recent studies.

On the positive side, he includes a

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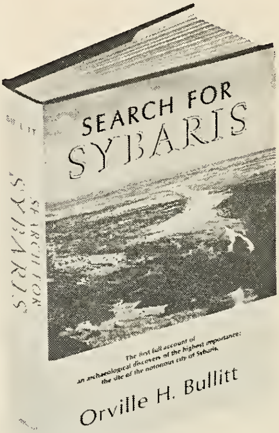
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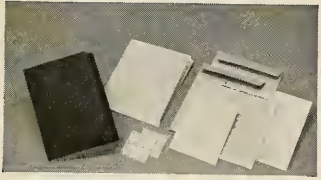

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great deal of information about artifacts and other evidence found at important European sites. The most famous of these sites is the one in the Neander Valley near Düsseldorf, Germany, where fossilized bones were discovered in 1856, a time when the world was not yet ready to accept the idea of evolution, human or otherwise. Most Victorian authorities believed the remains were those of a modern individual suffering from some severe bone disease rather than an extinct type of human being, and Neanderthal man has been held in low esteem—by laymen at least—ever since. Most people today recognize that he is a fossil ancestor, but picture him as a kind of slouching half-ape. Stern does his best to set the record straight, emphasizing that the Neanderthals belong to "the proud ranks of sapient men."

Unfortunately, the author perpetuates a number of other myths. For example, he presents as generally accepted opinion the notion that we arose from "luckless creatures" forced to abandon the trees for the savanna because times were becoming drier, forests were dwindling, and there was nowhere else to go. A notion more in line with current evolutionary concepts is that life is continually on the move and that our ancestors may be traced to apes who ventured into open places near forest margins, probably to get at underexploited sources of food.

To be sure, some anthropologists still make use of the old theory in their writings. But scientists are not always right, and this fact represents one of the science writer's main pitfalls. He must be on the alert and avoid them for his own protection, certainly no easy task. Stern is not in touch with many fresh approaches to the analysis of archeological evidence, however, and his book suffers accordingly.

JOHN PFEIFFER
Science Writer

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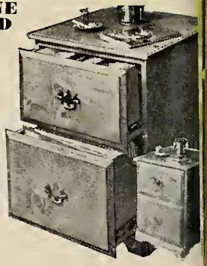

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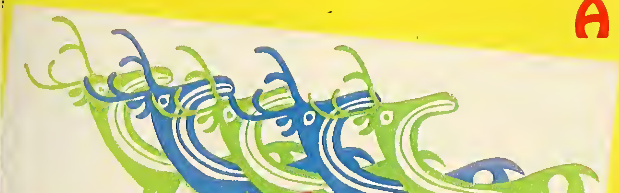

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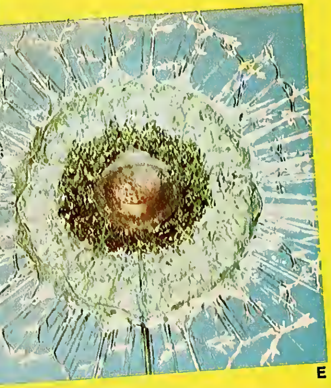

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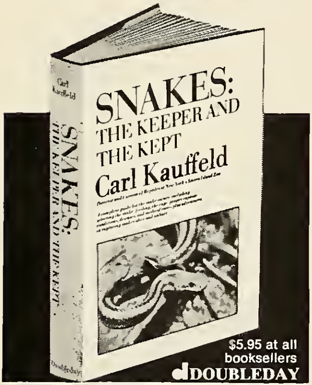

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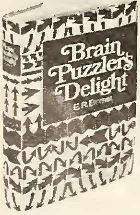

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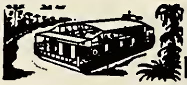

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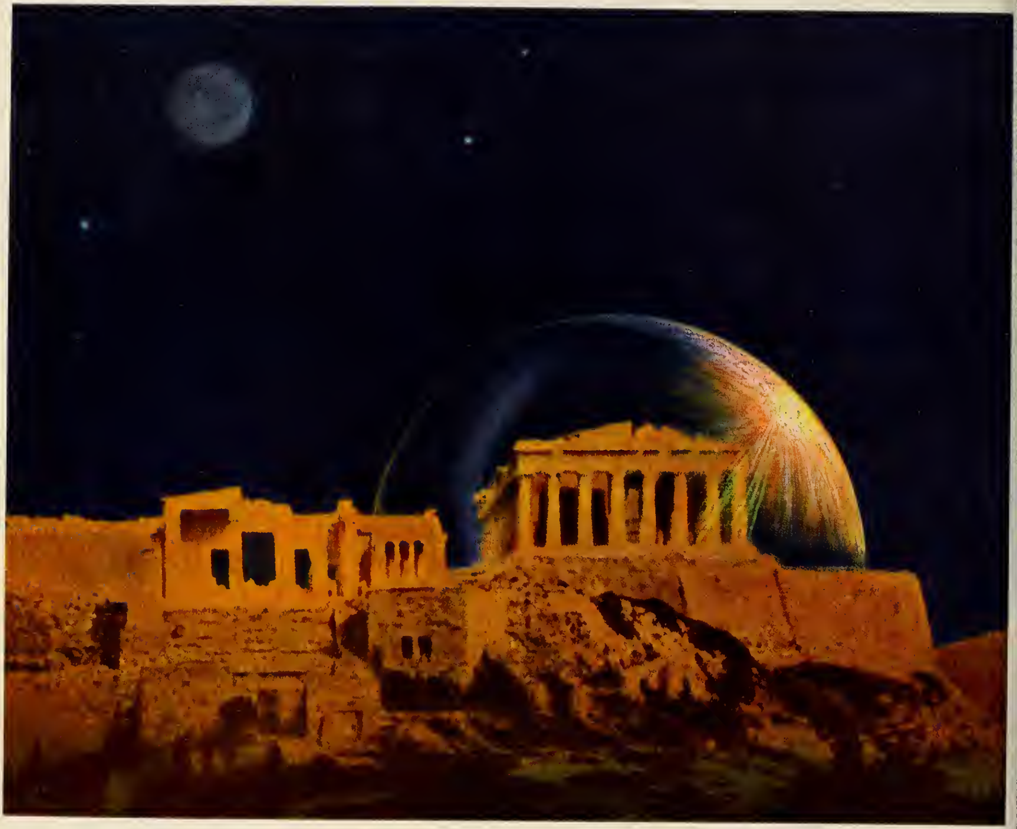

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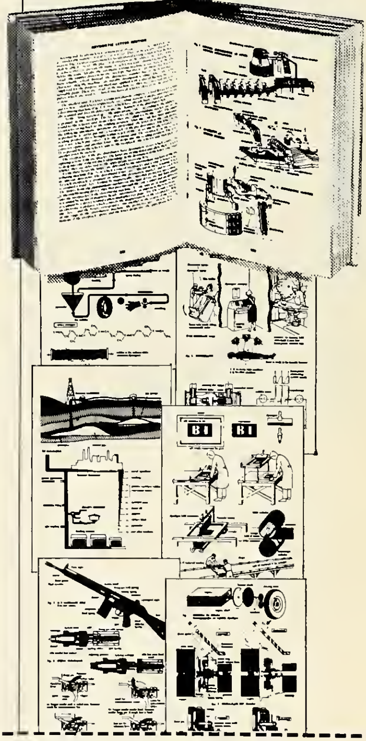

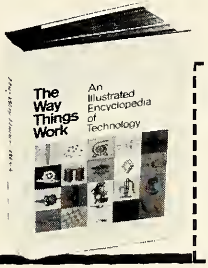
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Natural History

INCORPORATING NATURE MAGAZINE

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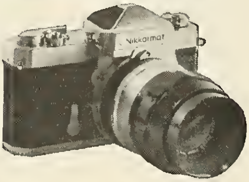

Marsden Emig's inventiveness widened communication between the seeing and the blind.

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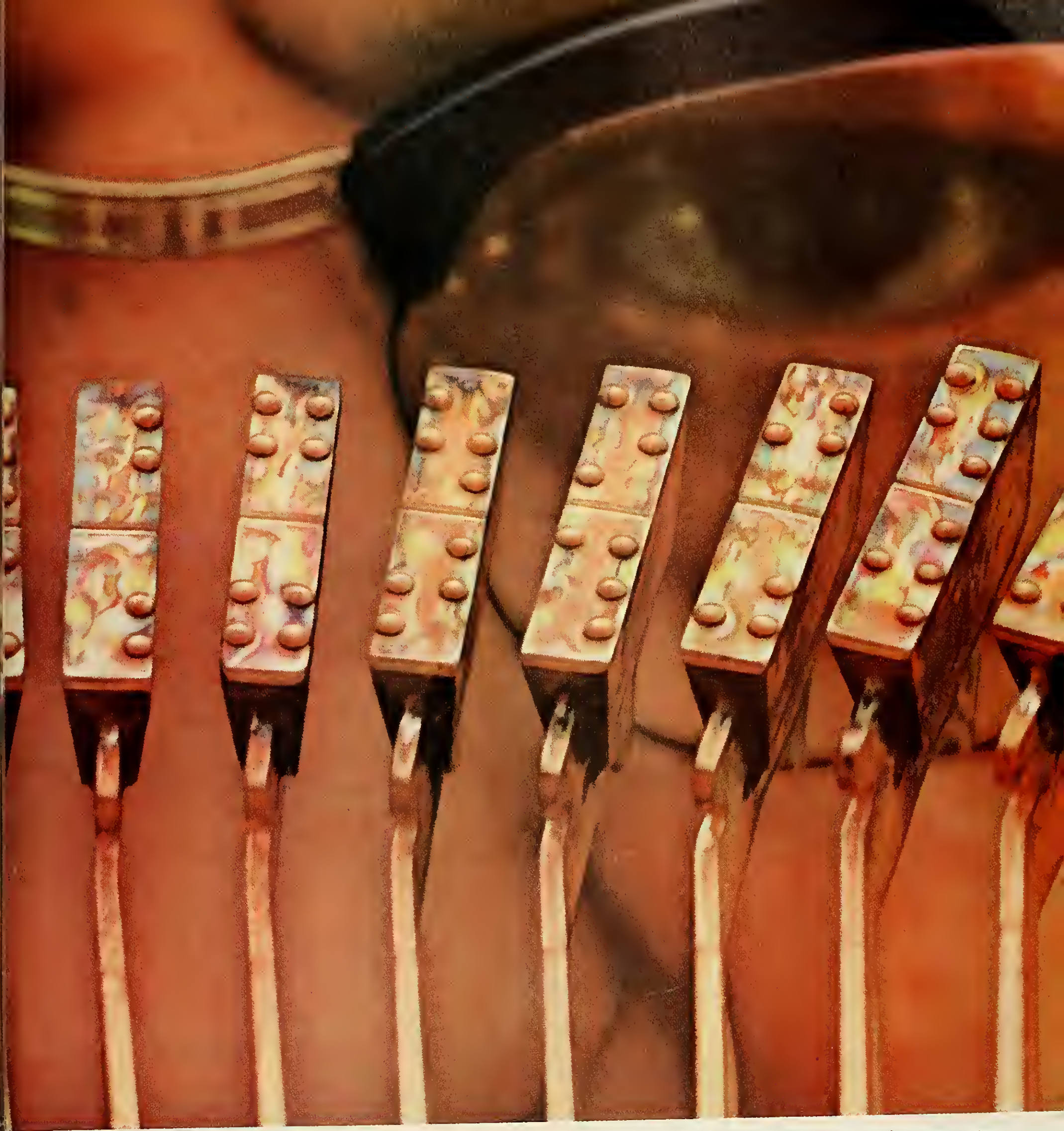

Close-up of the Braille keys adapted to an IBM electric typewriter.

"It didn't make sense to me," says Marsden Emig, an IBM engineer, "that a person had to know Braille in order to write to a blind person.

"The answer, I felt, was to adapt a standard electric typewriter so that anyone who could type, could type Braille. In this way, the advantages of Braille would be available to many more people.

"To print Braille, the type has to strike the back of the paper, and raise dots on the front. This is almost completely 'backwards' for a typewriter. But the idea fascinated me.

"In 1964, I decided to do something about it. I worked at home, in my spare time. After three years of plugging away at the problem, I finally developed the right Braille typewriter slugs and the necessary typewriter modifications.

"In 1967, I was able to type a letter to Fred Gissoni, a blind friend who was a consultant. The day after I wrote to Fred, I took the prototype to the office and proposed that my company manufacture the machine. Less than a year later, the first commercial IBM Braille typewriters were in use.

"Why put so much spare time into a Braille typewriter? Because a real need existed. An important need. And I was pretty certain that if I could figure out a practical way to do the job, IBM would work out a way to turn it into a reality. Today, the Braille typewriter exists."

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THE AUTHORS

Ken N. Sokolski

Jerome Lettvin

James Deetz

John T. Reynolds

Paul A. Erickson

David A. Caccio

Edward Abbey

Our youngest author in many years, Ken N. Sokolski, is a 14-year-old freshman at South High School in Torrance, California. For half his life, he has studied tide-pool denizens, particularly octopuses. His article on "Buster," an octopus that lived for seven months in his home aquarium, was first published as an entry in a local school district science fair. Mr. Sokolski, who wants to make a career of biological research, spent part of the summer of 1968 studying the ecology of an open lot near his home.

Jerome Lettvin is Professor of Communications Physiology at Massachusetts Institute of Technology. His own recent work with the octopus has resulted in a book, *The Head on the Shield of Pallas*, which will be published shortly by Gambit Press. It treats literary, as well as zoological, aspects of these eight-armed cephalopods.

James Deetz divides his time between Plimoth Plantation and Brown University, where he is, respectively, Assistant Director and Professor of Anthropology. A graduate of Harvard University's Department of Anthropology, Dr. Deetz received his B.A. in 1957, M.A. in 1959, and Ph.D. in 1960. He has been affiliated with Plimoth Plantation since 1959 when he first became interested in colonial archeology, and has done field work in North American archeology in the Great Plains of South Dakota, in New England, and in California. Dr. Deetz is the author of *Invitation to Archeology*, published by Natural History Press in 1967.

Paul A. Erickson has combined a career in biology with one in sociology, which he defines as "only human ecology." He finds that each field naturally leads to the other as he moves between microbial and human relationships. Mr. Erickson is a research assistant on the Water Resources Council of the University of Massachusetts and a lecturer in social anthropology at Quinsigamond Community College and at Clar University Evening Division.

After two years of postdoctora work in marine microbiology, Joh T. Reynolds began his study of th Quabbin Reservoir in 1965. He i specifically interested in the ecological significance of cell-destroyin bacteria in aquatic environments Dr. Reynolds, Associate Professor o Microbiology at Clark Universit and Adjunct Associate Professor a the University of Massachusetts, too his degrees in biology, bacteriology and microbiology.

David A. Caccia, who took the photographs on pages 54-57, spent several years exploring the coastal region of New Jersey known as the Pine Barrens. His interest in cranberries developed from his study of the Barrens, an area now threatened by the possible construction of a jetport. Mr. Caccia is a writer and sculptor as well as a photographer.

The author of *Desert Solitaire*, a book on the canyonlands, as well as of several novels and magazine articles, Edward Abbey appeared as our "Naturalist at Large" in April, 1969, with his article, "City of the Prophecies—a Hoboken Perspective." Presently a fire warden at Grand Canyon National Park, Mr. Abbey's primary concerns are "the liberation of women, the preservation of wilderness, and a new and better American Revolution." He is currently working on a screenplay for the American Film Institute.

Barbara Smetzer's article, "Night of the Palolo," is the result of two years of research and field work on the palolo in American Samoa (1967-69). A member of the American Folklore Society and the North Carolina Folklore Society, Mrs. Smetzer received her master's in folklore from Indiana University in 1963. At present, she and her husband are working on a series of ethnographic films depicting traditional Samoan life.

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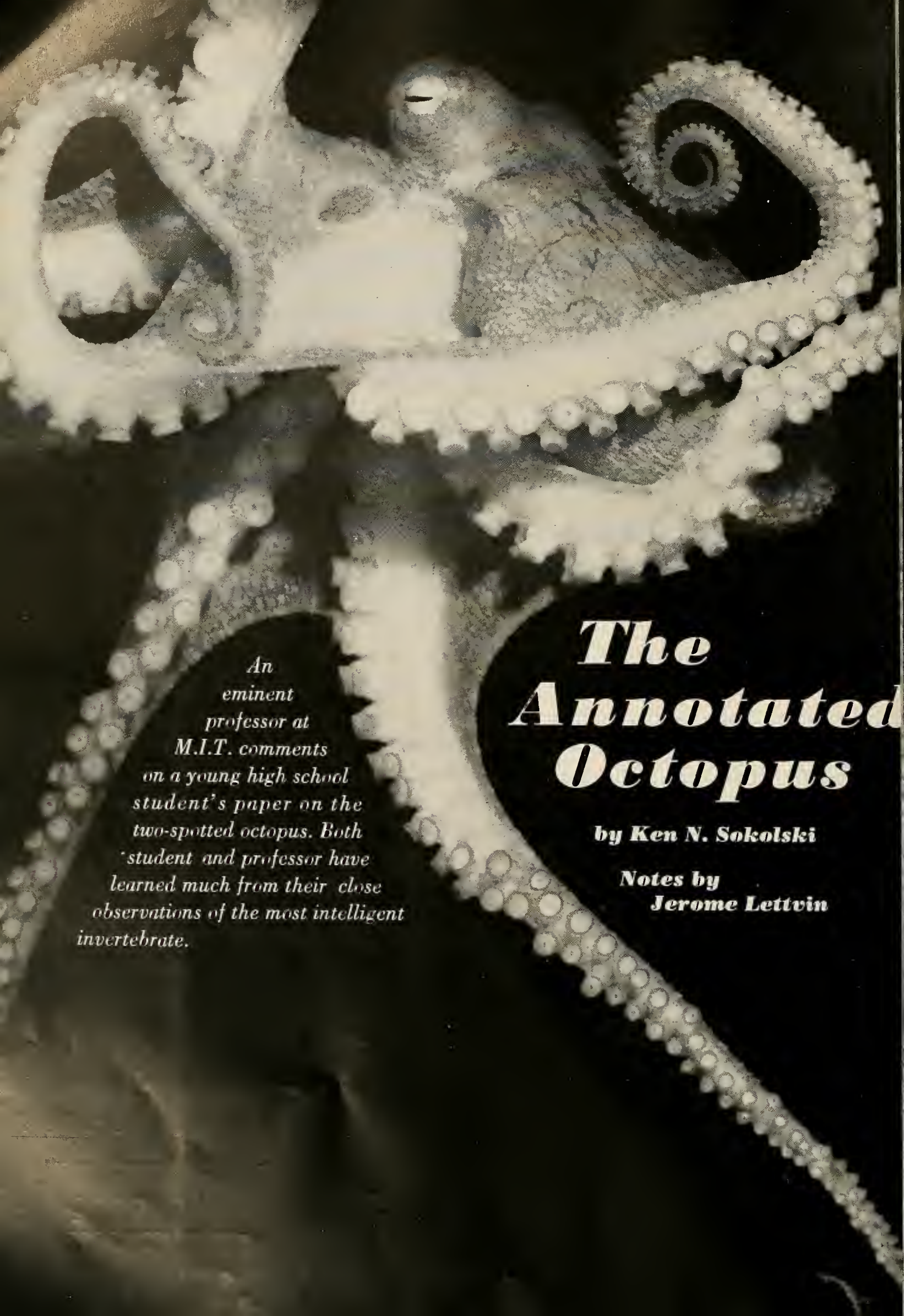

The Annotated Octopus

An eminent professor at M.I.T. comments on a young high school student's paper on the two-spotted octopus. Both student and professor have learned much from their close observations of the most intelligent invertebrate.

by Ken N. Sokolski

Notes by Jerome Lettvin

My interest in tide-pool life began ıen I was about seven years old. lived (and still live) in southern ılifornia very near the ocean, and as fascinated by the creatures and crets of the sea. But it was not until year later that I attempted to colct specimens. With little knowledge ' the animals and their environental needs, I put them in a large ckle jar. My first experiment was a saster. All died in three days.

Six months later, I received a ıree-gallon tank for my birthday. y then I had read about how salt ater corrodes metal, resulting in poison that kills specimens. This ew tank was made entirely of plasc. I collected some specimens—an paleye, some hermit crabs, and an ctopus—at "The Cove," an area ith many tide pools and exposed ɔcks at low tide. The opaleye and ermit crabs caught my attention, ut it was the octopus that held me ondering, thinking.

After studying octopuses in a fifɜen-gallon tank, I received a much etter study area: a fifty-gallon quarium. I returned to the cove one fternoon and caught a young octous, about six weeks old and about ight inches long with his arms tretched out. I named him Buster.

A search through my classification ooks taught me that Buster was a wo-spotted octopus. I found that it elonged to the phylum Mollusca—aving soft, unsegmented bodies with trong, muscular feet (or only one oot, as in the case of the abalone). he name of its class, Cephalopoda, neans that its head bears long arms, nown as tentacles, which are equiped with suction disks. The order is ibranchia—cephalopods having one air of gills closed in the mantle avity. The family is Octopodidae; he genus, *Octopus*; and the species, *imaculoides*.

Next I looked for more about the wo-spotted octopus, and this is what found out. It is common in southrn California waters, but its range s from San Pedro to Panama. It ets its name from two round spots n either side of the head in back of he eye. The spots have a dark-rown center, a dark-blue ring round that, and then another thin ark-brown ring. This species grows p to about twenty inches. In genral, an octopus skin may be perectly smooth or decorated with artlike projections called papillae. Often, a cone-shaped filament protrudes above each eye. The arms are usually about three to four times as long as the body. Also, an octopus has a strong black beak, located on its underside where the arms seem to meet. The beak is used to crack the shells of crabs and lobsters in order to reach the meat.

An octopus lives under rocks in the sand in the outer tide-pool zone. It prefers flat rocks with a small amount of water under them. To my extreme interest, I learned that its eyes are as highly developed as ours, and it has a larger and better functioning brain than any other invertebrate. Intelligence is important in its survival, for it must constantly search out food.

The littoral octopus all over the world prefers holes of any sort. It will crawl into an old shoe or into an empty can, as well as under rocks. This is the basis on which octopuses are trapped. In some places along the ocean shore all you need do is lower a set of containers into the water and drag them up the next day to find octopuses in them.

The Italians and Chinese, who value the octopus as a gourmet food, usually grind it, for the skin is very tough.

I have never seen ground octopus meat. The octopus is frequently pounded to make the meat tender. There was a time when the modern washing machine was said to be a big seller in Polynesia, because dead octopuses and squid were tenderized by being slapped back and forth in such machines. Octopus is also dried for storage, like shrimp and other seafood.

To catch a specimen is an art in itself. You may not find one at all after raising perhaps fifty rocks, a backbreaking task. Also, if you do see one and catch it before it slithers away and buries itself in the sand, its slick, slimy body is almost impossible to hold (this is why I try to let it gently slide from hand to hand).

If you make it this far, you must now gently and carefully slide the octopus into a bucket containing a rock and water. The risk here is that the octopus squirts out a blackish to purplish ink, and this would poison him if he remains in the bucket too long (in the ocean, the ink would disperse quickly). This is why one should be careful. I usually allow the octopus to attach itself to my hand, then gently put my hand into the water. Next I wait motionless until the octopus decides to transfer to the rock. Unfortunately, sometimes this method can take as long as fifteen minutes.

I am not sure that the ink of octopus is poisonous to itself.

If you manage to get the octopus into the bucket, your troubles are still not over. First of all, be sure that the water has not been in contact with any metal. Next comes a more normal health problem. It is wise to get the octopus home and into the tank as soon as possible. This is because it can get frightened and die in the small space of a bucket. Also, its oxygen supply may run out or become too low. Shifting an octopus into the aquarium is not as hard as catching one, and well-filtered aquariums will quickly clear up any

The oxygen requirements of an octopus are very high, and this is one of the problems in transporting it. The colder the water, the less oxygen the octopus uses; it might be a good idea to prechill sea water to about 58°F. before carrying the beast any distance.

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squirts of ink. After it has been "tamed," the octopus seldom squirts ink in the aquarium unless it is suddenly frightened. The tank should contain a "private home" for the octopus. It can either be some rocks or a suitable shell. For a home, I use a large pink conch shell into which the octopus can squeeze easily. There should be a supply of hermit crabs for the octopus to eat.

The ink comes from an ink sac gland located between the gills. It serves to confuse enemies while the octopus darts off and hides. It acts like a smokescreen to block the enemy's vision or possibly make it think that the ink is the octopus itself. In a small aquarium, it can be expected that a large concentration of ink would dull an enemy's sense of smell, thus making it even harder to detect the octopus.

From the literature I learned that in the ocean a main enemy of octopuses is the moray eel. This predator can swallow octopuses whole. Sometimes, however, the eel is able to get only one arm of the octopus. Then the octopus, like all multiarmed mollusks, can grow a replacement arm. This regeneration takes only about six weeks. An octopus recognizes the moray's sight and smell instinctively. From this, scientists have concluded that the two species are ancient enemies.

I also learned that some shellfish are treacherous enemies of the octopus. They have been known to hold down an octopus until it must give up an arm to get free. In the Australia region poisonous shellfish have been observed killing octopuses with their deadly venom. In addition, some species of starfish have been known to put octopuses into a state of paralysis for up to five minutes. Scientists do not yet know whether the starfish emits a paralyzing secretion.

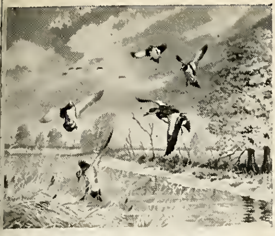
For escape, and other swimming activities, the octopus moves by the jet propulsion of sea water. To begin with, water enters through two gill openings, or "collars," at the neck. From there it is drawn into the mantle cavity. Then the strong muscles keep the gill opening closed. The water is shot out in a direction opposite to where the octopus wishes to go. Its speed depends upon the force of this jet stream. Streaking through

The ink that an octopus puts ou is frequently mixed with mucus in a interesting way. When the anima wishes to escape, it turns itself black and, at the same time, extrudes the mucus-ink mixture in a blob that appears to have the same bulk as the octopus. As the mixture is extruded the octopus turns white and scoots off. However much you have learned to expect this, your eye always stays with the black blob, and it is only after you realize that the blob is not the octopus that you look for him elsewhere. The ink itself smells of octopus, and from the point of view of a moray eel, makes him smell-blind (like a man trying to locate a skunk after it has sprayed), so that he can bump his nose against the octopus without being able to tell it is there. The moray eel is a vicious animal. It has extremely sharp teeth and is much feared by skin divers. It does not have particularly good eyesight, but does have an excellent sense of smell. A drop of octopus ink put into a tank where morays are, excites them violently, and they will even begin snapping at each other.

The regeneration of a replacement arm in the octopus takes much longer than six weeks in the species that I know about, but admittedly I have not dealt with young octopuses.

The entrance of water into the mantle cavity is usually controlled by the closing of valves. It is an interesting exercise to imagine how the flabby sac of the mantle can suck water in when there is no skeleton. Remember that muscle can only contract; then try to design the method of respiration. Imagine that you have an ordinary balloon. What set of muscles would make it self-inflatable? The answer is amazing, but I will not give it here because it is so pretty a problem that everyone should have a chance to work it out himself.

The funnel through which the water is jetted out from the mantle can be aimed well. It is fun to watch the octopus clear the debris away from around his hole, like a tidy housewife using a blower rather than a vacuum cleaner.



"WIDGEON ALONG THE RIVER"
by Roger Preuss, F.I.A.

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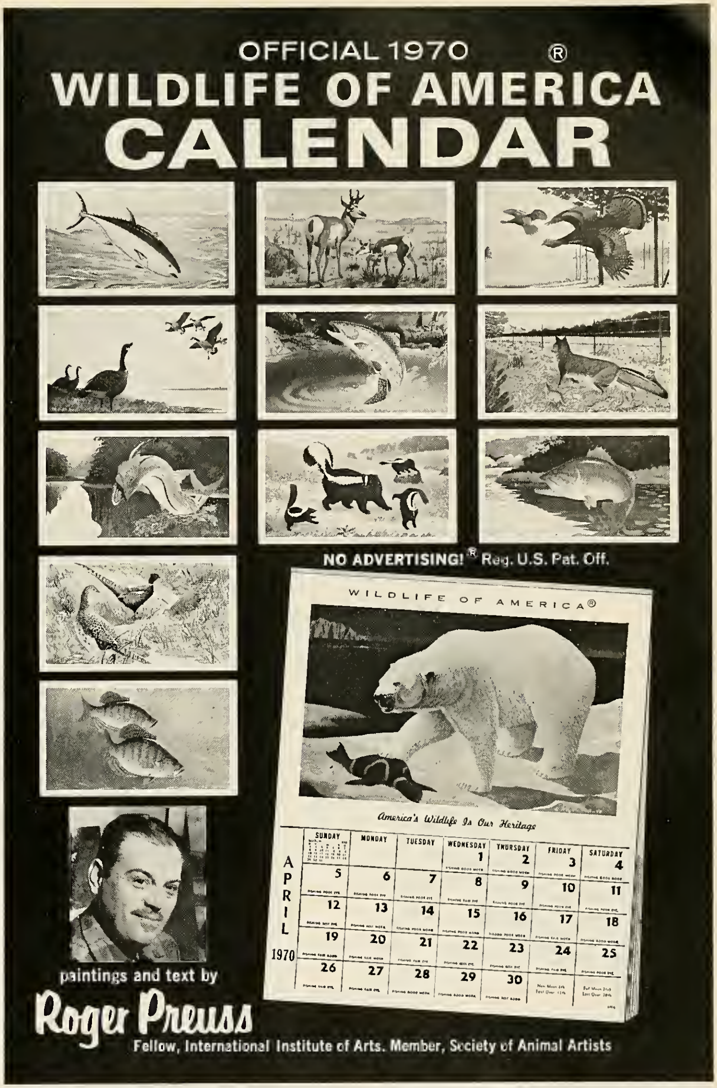

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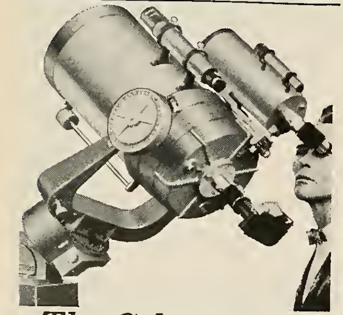

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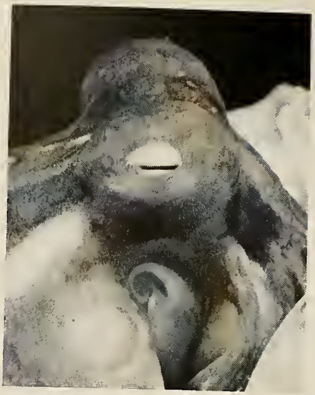

the water, at certain speeds its body looks extremely streamlined.

I have noticed Buster propel himself, over and over again, up to the surface, then drift to the bottom at the same corner of my tank. I don't know if this is for exercise or not, but it sure looks that way. Buster's other means of transportation is to crawl along the bottom of the tank, using some tentacles to move, and others for holding on to rocks. I have also noticed him holding on to the aquarium glass with one tentacle, while poking his other tentacles and part of his head out of the water. Is this curiosity about his environment and the outside world?

From My Journal
November 21

Octopus is in its home shell, holding on to the walls with all tentacles. Closes eyes, backs deeper into shell when light is turned on. Changes from light brown to dark brownish black. Eyes follow finger across tank. Closes one eye, observing me with other. As I draw near, seems to breathe more times per minute. Attempts to cover itself with its tentacles. As I move away, breathing slow. Light turned off, octopus closes eyes, becomes pale.

November 22

Light turned on—heavy breathing, then calms down. In shell as usual. Has orange around eyes. When I stare at him, seems disturbed. Follows me, then comes out of his shell against the glass toward me. Goes by shell, becomes brown with orange spots. Goes behind filter. Comes

So far as Buster propelling himse to the surface and then drifting bac to the bottom, I suspect that this wa due, in part, to the lack of oxygen i the bottom of the tank on warm day But again, I have no experience wit the two-spotted octopus. The octopu is an extremely intelligent anima and it is not only curious but is als very playful, in the same way tha you can say a dog or cat is playful I know that some people do not believe this. My son had a pet octopus which he called Juvenile Delinquent and he convinced me, after a fe months, that J.D. was playing, b this demonstration: Ordinarily, when you stick your finger into the wate close to an octopus, it takes fright o changes color at you. If it feels that the finger is something that it can cope with, it snakes out an arm or two, sucks onto the finger, and tugs. If you tug back, it either lets go instantly, or tugs back once or twice before letting go. J.D., however, after a few weeks, not only didn't seem to get nervous when my son poked his finger in, but actually played tug-of-war, using only two arms and neither releasing them nor bringing other arms into play. Also, J.D. seemed to recognize my son through the side of the tank, and this was most particularly true at feeding time.

I am surprised that Mr. Sokolski's octopus never escaped if the tank was uncovered. Octopuses are really escape artists, and because they have no bones, can squeeze themselves through incredibly thin slits. Incidentally, the word tentacle *is never used for the arms of the octopus. Instead, it refers to the two modified arms used by squid and sepia for grabbing prey. The tentacles have no suckers on them except at the tips.*

When an octopus is excited, it respires more deeply and more rapidly, and it changes color fairly quickly, particularly around the eyes. Mr. Sokolski is quite right in seeing the covering of the octopus by its arms as a kind of protective gesture. I wonder if Mr. Sokolski observed how the eyes seem to become very big and to stand out from the head, then almost disappear behind eyelids drawn together like a pursed mouth. It is not the eye that becomes big, rather it is shoved out by a big blood sinus that lies behind the eye and can be inflated at will by the octopus.

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around filter, becomes dark brown. Holds on to place where bubbles come out. Goes across front of tank. Holds on to rock and small clamshell toward front of tank. Sticks head in home shell. Then takes tentacles in.

Browses through the snailshells that hermit crabs borrow to live in, sticking tentacle tips into them to learn if they contain any crabs now, doesn't take any. Then eats a few hermit crabs, and discards the shells. Every time I get near, he violently and quickly shoves himself into his own shell.

November 23

Octopus in shell. Light already on. As I approach, octopus has orange spots. Brings in its siphon. Gets darker in color. Sticks tentacle toward me. Spot becomes much darker. Usually uses only one siphon at a time. When I try to take hermit crab shells, shoots tentacle out at me and removes as many of the crabs as he can hold, storing them away. He guards them, and if I bother him, he shoots tentacle out at me (is sensitive to sudden movements). Just as we get red in the face, color changes seem to express his feelings.

November 24

Octopus browsing around hermit crabs, and taking a few. Octopus blanches, turns pink and gray while he is in shell. When angered, becomes fully brown with dark orange spots.

I think that when he becomes frightened, a message is sent to the brain. As I understand it, the brain tells a gland to secrete a surge of adrenalin, which is the cause for the quick breathing. Another message to the brain designates color.

The more frightened the octopus is, the more extreme are his symptoms of fright. In many cases, when frightened he changes color to look like his environment. He can vary the size opening of his pupil, so can see well at night, as well as in the day. When frightened, he prepares for action and is ready to shoot any of his tentacles out at a moment's warning.

Mr. Sokolski makes a good observation. The feelings of the octopus are displayed in the color change, and after a while we can read them to the same extent that we can read the expressions on people's faces.

Mr. Sokolski here makes a mistake that is very common, also, to older scientists. While it is true that the octopus has a complex system of glands as well as a complex brain, nobody is sure which part does what. For example, we men do not have very good direct control of our own blood circulation, while the octopus apparently can control the movement of blood in its body with great speed, by shutting off one vessel and opening up another through direct nervous action. Furthermore, the brain of the octopus is distributed rather widely. You can look upon the octopus as a head with eight bodies attached to it. Each arm has its own nervous system, just as a man's trunk contains a spinal cord. When an arm is cut off an octopus, the arm will crawl away on its own, sucking onto surfaces and letting go exactly as if it were being instructed by the octopus itself.

The color changes are also under direct nervous control. The octopus skin has color cells called chromatophores. Ordinarily these are contracted to a pinpoint. Each chromatophore has several radial muscle fibers attached to it and anchored in the skin. When these muscles contract, the chromatophore spreads out into a thin sheet. The effect is like putting a small drop of ink on a sheet of paper and then smearing it out over a wide area by placing another piece of paper on top of it. If you buy a squid in the fish market, you can see this effect rather nicely (although not as it appears in the live animal). On the skin of the dead squid there will be lots of purplish patches and in their neighborhood, some small dots. If you rub a wet finger gently over this region where the small dots are, they spread out, like ink spots, into large patches. The octopus has three different colors of chromatophores to play with, and any chromatophore can be spread out or allowed to contract to a point in a twinkling of an eye.

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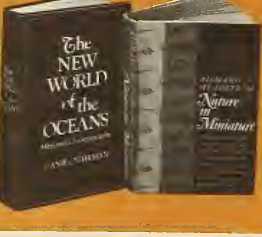

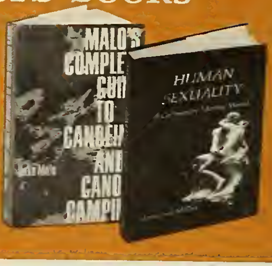

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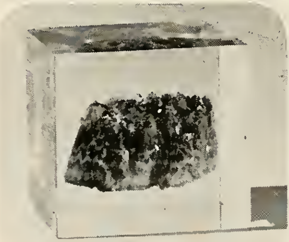

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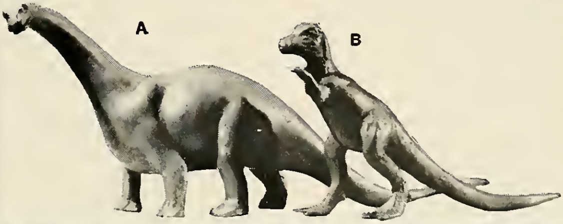

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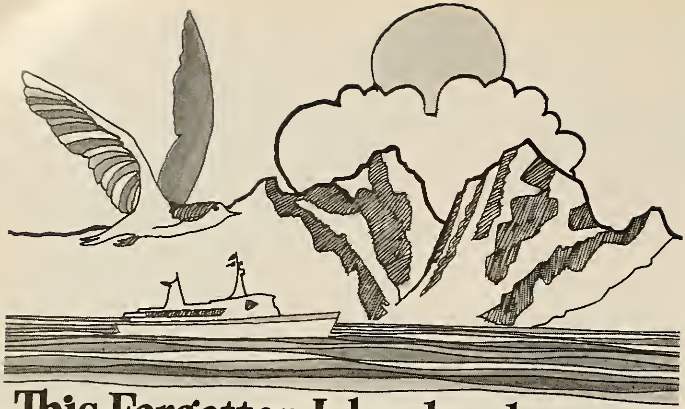

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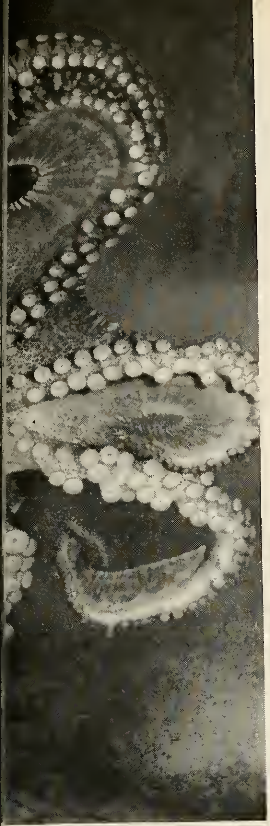
SEYCHELLES

January 9

I have noticed that Buster c
change the "whites" of his eyes fr
white to orange to brown. He is
his shell. His tentacles are whit
his head and sac are grayish brow
When he was a baby, his ink sac w
not highly developed. But now he
about nine months old. Like a reb
ling teenager, he squirts ink when l
seems frightened. He always mov
the delicate, sensitive tips of his te
tacles out of his shell first, before h
body. There may be two reasons f
this: to feel for alien materials an
in case of sudden attack, to save h
precious body and lose only the ti
of his tentacles. Usually, however, h
can bring in the tips very quickl
Buster seems to enjoy ordinary cra
—the striped shore kind—more tha
any other food. Through highly de
veloped smelling devices located i
projections near the eyes, he follow
the crab's tricky maneuvers perfec
ly, until the crab is cornered. Th
octopus snatches up the crab (usual
ly with one tentacle) while crawlin



ne pupil and the eyelids of the
pus are the same structure.

ebelling teenagers, frightened,
not squirt ink. This seems to be
e analogous to the propaganda
of our government.

is a wrong observation to think
the octopus has smell devices
the eye that follow a crab's
ement. The smell-taste organs
mainly situated around the lips
he suckers. It is true that there
so-called olfactory ganglion be-
th the optic lobe (the visual brain
he eye), but it is not certain that
name is justified. In any case,
octopus is a very visual animal
hunts entirely by sight. It is not
sible for a blinded octopus to
t for food. Food has to be given
he arms.

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back to his home shell to devour it with the others. With his grayish-black beak, Buster cracks the crab's exoskeleton. then sucks in the meat. His mouth is located at the bottom, in the middle of all eight arms of his somewhat symmetrically shaped body.

He usually disposes of the crab's shell material somewhere in the middle of the tank. which makes a smelly mess of the whole tank, which is why I usually feed hermit crabs to the octopus. Buster gathers them in one

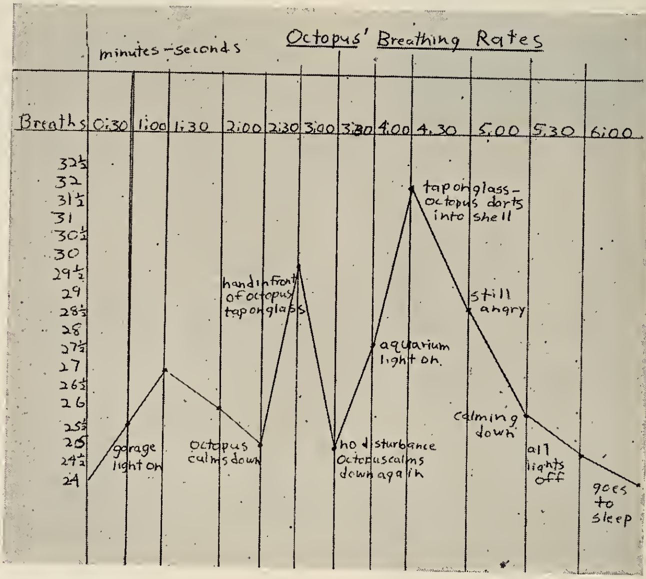
Incidentally, the crab is paralyze by the octopus saliva in the same wa a spider's prey is immobilized.

INVESTIGATION

Purpose: To observe changes in breathing rates of octopuses.

Procedure: First, I observed and recorded the octopus's breathing rate while it was awake and moving during the day. Next, I observed his breathing rate while he was sleeping. Lastly, I observed it when he was frightened (to do this, I moved suddenly in front of the glass).

Results: He took 29 breaths per minute when sleeping, 40 breaths per minute when awake, and 52 breaths per minute when frightened (these are all averages). He switched siphons many times. The octopus took short "panting" breaths when frightened.



Conclusions:

1. The octopus uses little oxygen while asleep.

2. In trying to get more oxygen to his body cells so that he can be prepared for anything, the octopus breathes heavily, but quickly, when frightened.

3. Like humans, the octopus needs more oxygen in his body for more oxidation and energy to perform more strenuous tasks or to have an extra amount of energy for an emergency.

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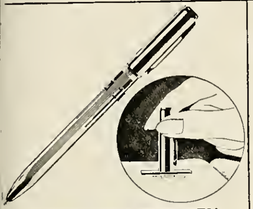

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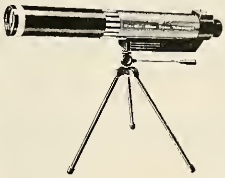

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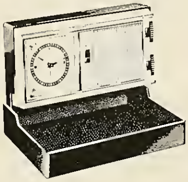

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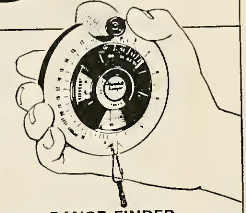

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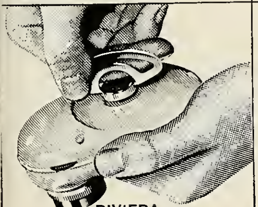

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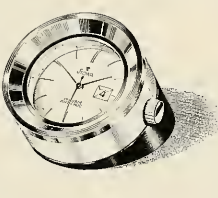

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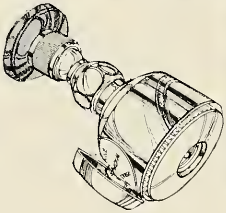

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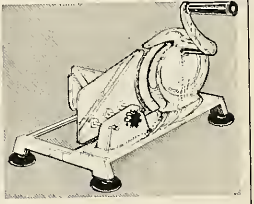

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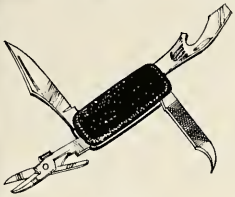

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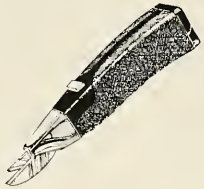

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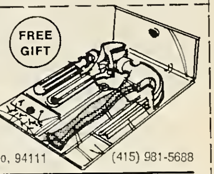

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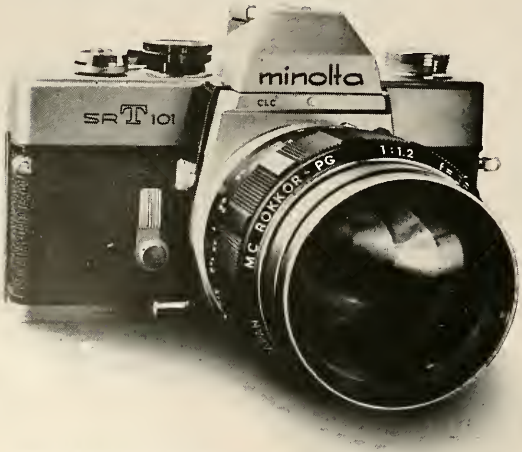

The Minolta SR-T 101 35mm Reflex Camera

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arm, or in the webbing between h arms. He likes to store the herm crabs in his home shell, but som times he gathers them one at a tim pulling their bodies out of thei shells and devouring them. He usua ly deposits the emptied shells in a pil next to his home shell, ready fo me to clean them up. Sometimes though, he thinks I am taking liv hermit crabs and insists on grabbin my cleaning net with such tremendous force that I can't get it loos until he has checked every deposite shell. Many times he is right, for th hermit crab can pull itself so far inside its borrowed shell that the shel will seem empty. In such cases, I drop the shell right back into Buster's lair. I had read in a book that octopuses do not like to eat snails. But there was the time when Buster wouldn't eat. He acted like a gourmet, saying, "the nerve of you to feed hermit crabs to me!" The next time my father and I went to the cove for specimens the tide was too high to collect hermit crabs. We had to resort to a substitute food—snails. To my surprise, Buster devoured them at first. But later he changed his mind and hasn't eaten snails since.

For my aquarium I also collect eel-like fish with large eyes—they are the only fish with (artificial) eyelashes located on the top of the head. Buster loved to chase these slow-moving fish. called cabezones. They are very awkward and move on the tank bottom. One night, he caught one. I knew he was the culprit because he discharged the bones in the usual place. The octopus looked sick after that, and I didn't observe him eating for at least a week. In fact, that was the last time he ate any fish (except for small perch). He is content now with his first food, hermit crabs.

The two-spotted octopus, such as mine, has disks (suckers) on the tentacles, and they are in two rows. The largest pairs are usually the tenth ones. And they are about one-quarter inch in diameter. The smallest, at the tips of the tentacles, are about the size of a pinhead. The octopus can move his head up and down. He can spot shadows easily, but does not seem to spot objects outside of the aquarium in the dark. He is nocturnal; his eyes, much like human eyes, are able to adjust to darkness by en-

ne Koerners aren't trying to save the world. st a little piece of it.

Romero is a small farm village ing to the mountains of Colom- South America. Poverty is ex- e. Illiteracy is almost total. Elec- y, sanitary facilities and run- water are nowhere to be seen, small children haul water from iver three miles away. There is hool in the district, but convinc- parents that education should precedence over water-hauling hard argument to win.

The Fuentes are one of the vil- families. Poor even by Romero's standards. The mud-brick house dirt floors they live in isn't even rs. The two-acre farm behind it vides all the income for the fam- f nine. Most of the time there enough to go around. Yet, this been a good year for the Fuentes. ir 7-year-old daughter Luz Ma- a has been able to stay in school.

This miraculous stroke of luck is ause of a family living in New k, who are helping Luz Marina. ey're the Koerners. Through Save Children Federation, they are tributing $15.00 a month to help.

For Richard and Marianne Koerner the $15.00 a month is not an extreme sacrifice. Yet, with three robust boys of their own, there are many ways ey could use the money. But Rich- d, whose job involves foreign travel, esn't have to imagine the poverty Fuentes endure. He's seen it. He ows, too, that Save The Children n do a remarkable number of ings with the money.

First, Luz Marina's immediate hool needs are taken care of. Sec- dly, funds are available to the mily to carry out their self-help an to raise hens. The eggs will help prove the family diet and in- ease the family income. Finally, small portion of the Koerner's con- ibution, together with money from her sponsors, has been lent to the llagers. With their own hands and weat, they're building a water storage tank and a pipeline. Hopefully, the new water supply will increase the crop yield and the village's income so that some day they will no longer need help.

Self-help. That's what Save The Children Federation is all about. Although contributions are tax-deductible as a charity, the aim is not merely to buy a child a few hot meals, a new coat, or shoes. Instead, your contribution is used to give people the boost they need to start helping themselves.

Sponsors are desperately needed for children in Korea, Vietnam, Latin America, Africa, Greece, the Middle East, as well as Appalachian and American Indian children. You can select the child's nationality and will receive a photo, regular progress reports and a chance to correspond and visit.

Richard Koerner hopes that one day, one of his business trips will enable him to meet the Fuentes. Many sponsors do visit their children, and tell us that it is one o the most gratifying experiences o their lives.

The Koerners know they can' save the world for $15 a month. Jus a small corner of it. But, maybe tha is the way to save the world. If ther are enough people like the Koerner How about you?

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larging the pupils to let in more light The octopus does not seem to min little fish, it even seems to protec them behind its shell from big fish Perhaps this is because big fish sometimes poke at the octopus.

February 26

As I think back to January 11, I remember going into the garage at the usual time to feed my fish, and observe how the other tide-pool life (mainly the octopus) were doing. (I used to stand there watching for fifteen minutes, even though I was late for school.) On January 11, after about seven months in captivity, Buster died. He was pale and limp, and the hermit crabs were feasting on him. To keep an octopus for more than several weeks requires a person who understands an octopus's needs and can cater to them. However, to keep an octopus in captivity for as long as seven months was gratifying. It gave me a rewarding chance to study the octopus and the way it lives. It is one of the most challenging, sensitive, interesting, and rewarding animals that a person could keep and study.

It was a delight to read Mr. Sokolski's first-class observations and first-class natural history. He is indeed skillful to have kept an octopus alive in a home tank for seven months. Generally students do not get the relaxed personal experience of such a pet and do not realize the extraordinary and nonhuman nature of animal intelligence. When you consider that the octopus has evolved from the clamlike things, the way we have evolved from fishlike things, that it is possible for Mr. Sokolski to begin to understand an octopus seems, in a way, miraculous. We tend to gauge the world in the light of man as the pinnacle of evolution, but the octopus is the most intelligent invertebrate in the same sense that man is the most intelligent vertebrate. There is no common ancestor between it and us that could have been anything more than a blob. It is the embodiment of an alien mind, like a being from Mars, yet somehow some mutual understanding can be reached. To me this is a matter of great wonder. I think if I could be reincarnated, I should choose to be an octopus.

Again, let me congratulate Mr. Sokolski on a finely written essay.

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A Naturalist at Large

A Field Guide to Field Guides

by John Eastman

The thing to do when looking at birds, bees, or trees is to carry a field guide. That's what I was taught when I was studying to become a biologist, and it's a habit that continues to curse me. I now feel guilty about leaving the house for a stroll around the block without at least two field guides tucked in my belt. In my belt, because field guides are always a perverse half-inch or so too wide for the average pocket. They girdle the gut uncomfortably, and lend an impression to the gait of a fused spinal column. Bending, of course, is out; a sudden enthusiasm, I soon learned, can cause internal injuries. So the stiffness inherent to the hang-up is pretty obvious, and is not uncommonly apparent in gatherings of outdoor scientists.

While the field guides to nature aren't much good for informing you about the habits of their contained species, they're awfully nice for telling you what the devil that species you barely saw before it scampered was. In biology there are scamperers and nonscamperers. Field guides are useful for introductions, for assigning names to multihued packages of fur, feathers, scales, or chitin. To say nothing of all the leafy stuff. Names to a biologist, of course, are superimportant. A biologist isn't really interested in a mushroom or a flea until he can name it. Field guides to him are like rubber stamps to librarians or explosions to hunters. Going to have your hang-ups, got to have your tools.

According to a carefully cultivated mythology in certain biological circles, field guides are composed mainly for the use of "interested amateurs." True professionals, this condescending fiction goes, stand far above the use of such simple keys by virtue of superior knowledge, observational talents, academic degrees, number of publications, total commitment, grave good looks, or simple virtue. But anyone who associates awhile with outdoor professionals knows that such is far from the case. Indeed, field guides are, most often, the basic equipment of the so-called expert. Interested amateurs are in far shorter supply than his ilk, as many a prosperous guide publisher knows.

If a biologist is a firmly committed specialist, there's no big problem. A bird watcher, beetle man, or bush botanist can get away with one or two field guides splinting his torso. But the situation of an ecologist, say, is different. Ecologists want to know the identity of every living thing in sight. So they really have problems with all the field guides they must use. An ecologist needs a big belt, even if he's going to severely limit himself. If he goes all out in the outdoors, of course, he needs something more.

One ecologist tackled this problem by strapping a five-foot shelf to his back and carrying his library afield. His stiffness was soon replaced, I noted, by dowager's hump. Also, the sliding glass door on his shelf was continually banging around back there, frightening away all titmice and squirrels within a hundred-foot quadrat. Clearly, the noise introduced an artificial stimulus into the environment. So he tried it without the door, but the books suddenly unloaded in a jumbled pile every time he squatted to census the sowbugs. Then he'd spend ten minutes putting them back in taxonomic order so he wouldn't, in an emergency, reach for his moss manual and pull out Hubbs and Lagler's classic guidebook to the fish.

One drastic solution has been to leave all books in the lab and simply collect whatever we wish to identify—

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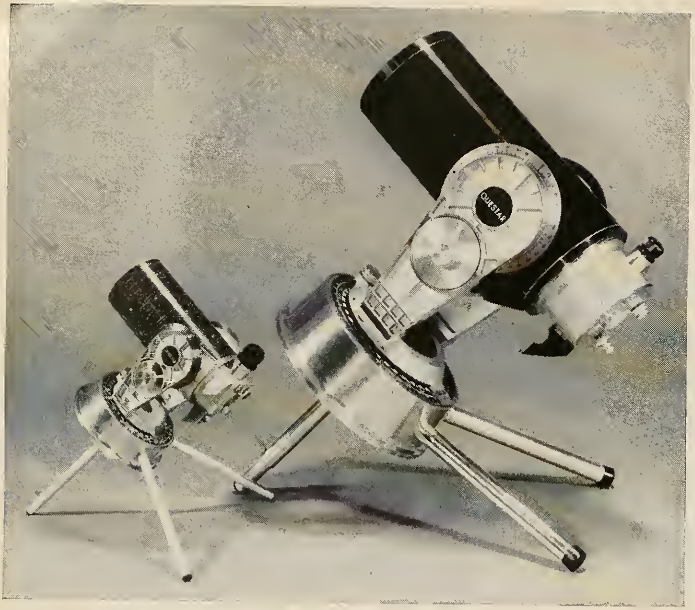

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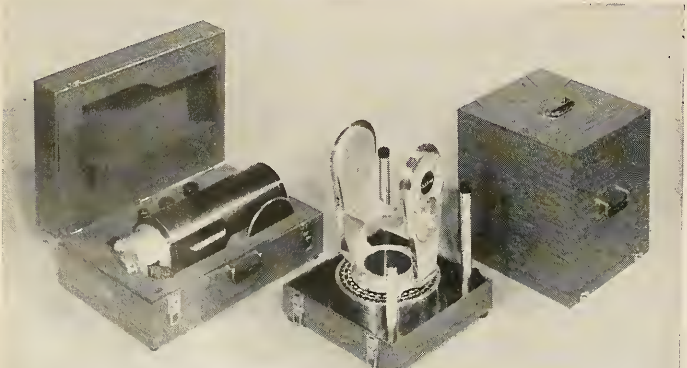

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bringing it back to consult the shelves at laborious leisure. But even this desperation can be overdone. Another ecologist I know was investigating a two-acre tract to determine energy-biomass relationships. I guess he got tired of so many trips to that meadow in his bookmobile. Anyway, he finally hired a fleet of dump trucks to bring his two acres indoors. Three big rooms of his lab are now packed to the ceilings with soil. He has enough biomass there for fifty years of research, a year for every foot of hole left in place of the late tract. That was two years ago, and though he's progressing nicely on the work, bushes are now bursting from the windows. This vegetation must, of course, be rooted out in order not to change the original character of the ground enclosed. But the last I heard, his department head was balking at providing a full-time maintenance man for this necessity. Obstacles to scientific progress truly abound.

There is now, to meet the needs of obsession, a profusion of field guides on the market. What is really needed at this stage, I believe, is a comprehensive field guide to the field guides, modeled after the Peterson guide system. The field guide I have in mind would point the bent and gouged ecologist to the best field guide for any field's endeavor. By best I mean the one that fits, mostly and literally.

The Peterson system marks distinctive features that quickly identify the species—it separates the hairy woodpecker from the merely downy one, say. For those who foolishly assume that any bird's name is even faintly descriptive of its possessor, hairy and downy woodpeckers are actually two similar species. You might never know that without the Peterson guide, which compares their salient points of difference. Each listing itemizes all species that could conceivably be mistaken for the one you're looking up. You can't go wrong (unless you really *are* an expert).

My field guide, however, would be for strictly indoor use. You'd look in it before you even belted your pants. It would, in fact, help you decide upon the proper belt to wear, as well as assorted liniments and rubs for after hours. My guide would classify all books by size and thickness first, then by cover color (so as not to clash with nature's decor), and only last and least, by quality of contents.

Such an addition to the burgeoning series of manuals would, I think, come as welcome relief to the student whose conscientiousness in matters zoologic or botanic knows no bounds. So equipped, my own perilous bounding over the bosom of Mama Nature would at least be reduced to the minimum feasible limp.

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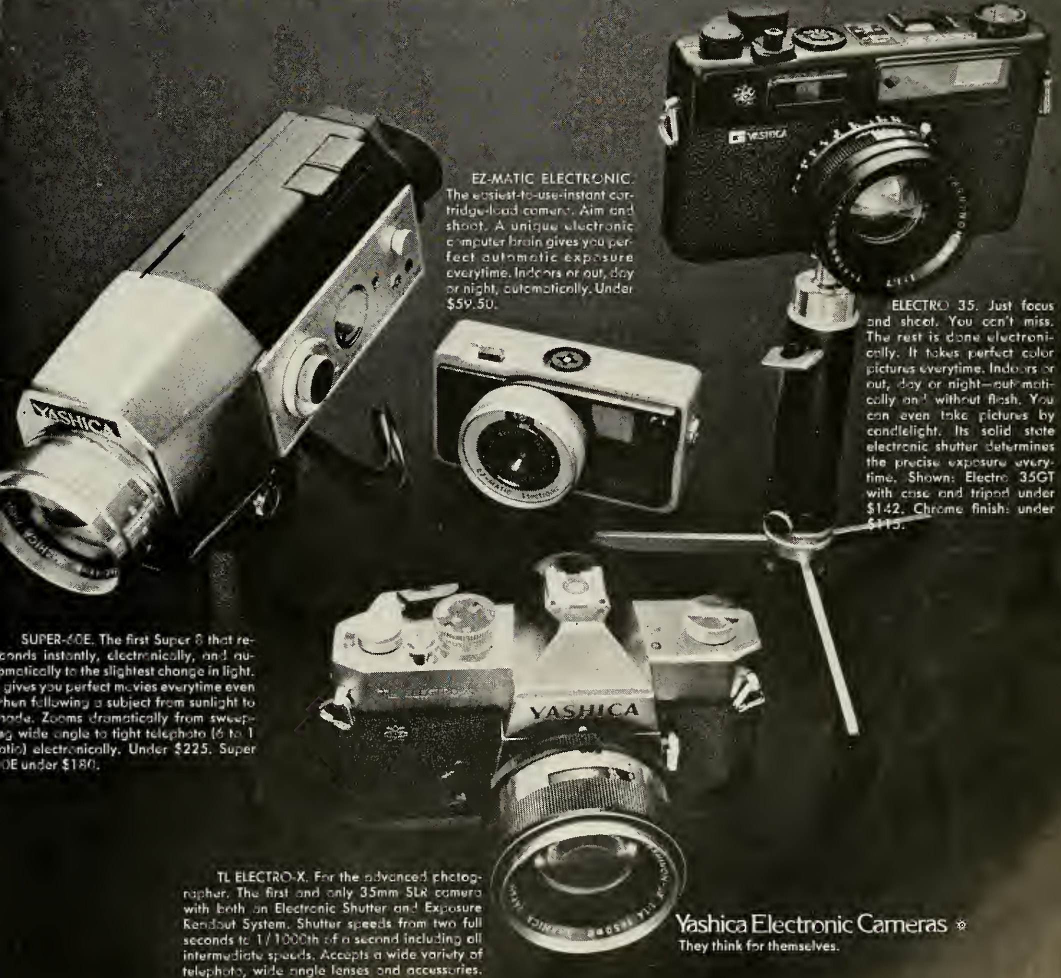

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THE REALITY OF THE PILGRIM FATHERS

BY JAMES DEETZ

A step into the time capsule of re-created Plymouth evokes a living community of Pilgrims—its smoky odors, animal noises, and household clutter—and dispels our misconceptions about colony life.

We present William Randall, and Elizabeth, his wife, of Scituate, for abusing the constable, Walter Hatch, in word and action, as by threats, and refusing to give surety according to the warrant, and that when he strained for the magistrate's table, his wife tore the distress out of his hand, and hurt his hand so that blood was shed.

We present Alice, the wife of Richard Berry, of Yarmouth, for going into the house of Benjamin Hammond, when nobody was home, and feloniously took away a woman's shift, that was new made, but without sleeves, and a piece of pork.

We present Joane, the wife of Obadiah Miller, of Taunton, for beating and reviling her husband, and egging her children to help her, biding them knock him in the head, and wishing his victuals might soak him.

We present Thomas Clark, of Plymouth, for taking of six pounds for the bare loan of twenty pounds for one year, which we conceive is great extortion, contrary to the laws of God and man.

We present John Peck, of Rehoboth, for lascivious carriages and unchaste in attempting the chastity of his father's maid servant, to satisfy his fleshy beastly lust, and that many times for some years space, without any intent to marry her, but was always resisted by the maid, as he confessed.

October the 1, 1661. Whereas I, Abraham Pierce, Jr., have foolishly and unadvisedly reported to Ruth Sprague and Bethiah Tubbs, at the house of Francis Sprague, that Rebecca Alden and Hester Delaney were with child, and that thereupon we should have young troopers within three quarters of a year, I do freely and from my heart own my fault herein, and am heartily sorry that I have so spoken, to their great reproach and wrong and the defamation of their relations, which I earnestly desire may be passed by of them all; and I hope I shall forever after take heed what I do speak and report of at any time.

Those, having viewed the dead body of the said Robert Allen, and heard the relations of those that were in the house of the said John Allen, where he, the said Robert Allen died, at the time of his death, do with one consent declare, that he came by his death by laying violent hands upon himself.

Mistress Lydia Garrett, of Scituate, to have liberty to sell strong liquors, in regard that sundry in that town are oft times in necessity. . . .

The total number of people who lived in Plymouth Colony during its independent existence—1620 through 1692, when it merged with Massachusetts Bay Colony—was probably not in excess of 10,000. The simple rural life was free of the complex social network of classes and occupational specialties characteristic of later urban centers. For this small colony, a wealth of documentary material, including church records, court records, probate data, tax lists, laws, and vital records, allows for controlled consideration of the many variables of social change. Unlike any of the other colonies of the time, the study of Plymouth is manageable. Furthermore, in researching its history and culture in depth, it is possible to set straight a host of misconceptions that most people hold of the "Pilgrims" and their seventeenth-century descendants.

By the nineteenth century the term "Pilgrim" had come to evoke a romantic image of these people. Genuine understanding of them was buried beneath a thick layer of idealized portrayals in prose, poetry, and painting. Even today, the Pilgrims are usually thought of as a rather cheerless lot, wearing somber dress and living in crude log cabins.

The Pilgrim fathers were, in fact, a people typical of their time, with a culture as different from that of Americans today as are many cultures of modern Africa or Latin America. From routine land dispositions through all manner of deviant behavior, the trials and troubles of the Pilgrim colonists were entered at court in thousands of cases, from 1633 through the end of Plymouth Colony's existence. Not that the Pilgrims were more rowdy or disorderly than any other group of early seventeenth-century colonists. They were simply human. Recently uprooted from relatively stable European societies, they faced in this

Closely spaced buildings in tiny, fortified Plymouth protected and reassured its isolated settlers.

fresh environment a whole new set of problems.

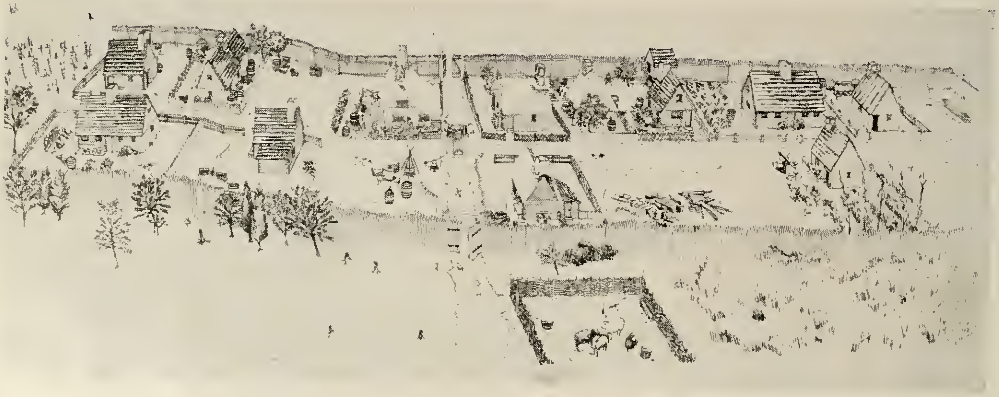
Perry Miller, the historian, aptly describes the small, earnest group who settled in the new land:

"The persons who made up the 'Pilgrim' company were homespun, hard-working farmers from Nottinghamshire and Lincolnshire; their minister, John Robinson, was a university man, and Elder Brewster had spent a couple of years at Cambridge, but otherwise they were men instructed only in the Bible and simplicity of spirit. They had openly broken with the Church of England, and proceeded to set up a completely 'separate' body. No government in Europe at that epoch would have tolerated the existence of such a society, outside and independent of the established institution, and it is no wonder that the bishops and the sheriffs of England got after this congregation with vehemence."

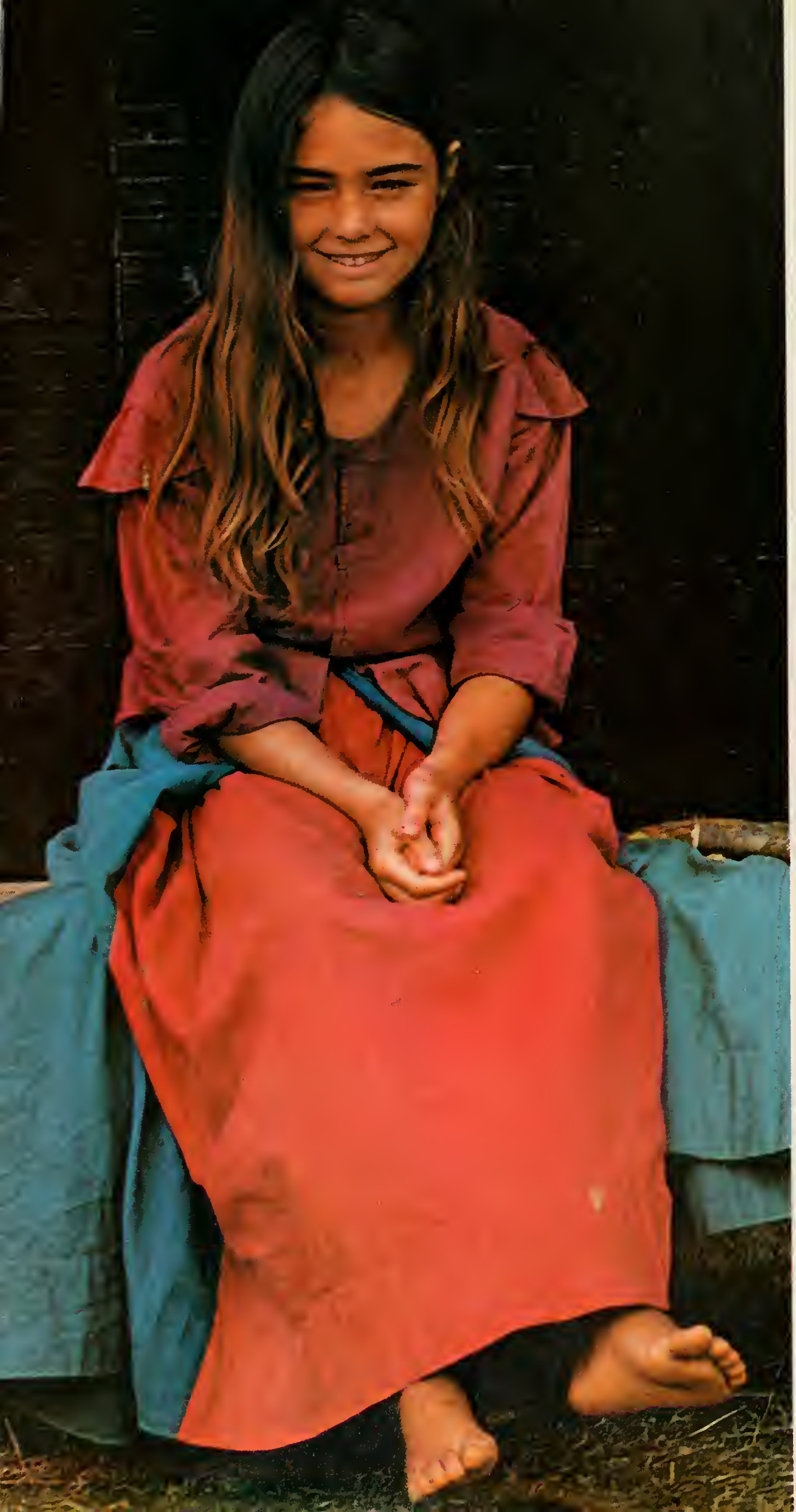
There is little doubt that these dissenters from the Establishment were a difficult people for their fellow Englishmen to adjust to, and England was probably more than happy to see them leave. Coming to America after a twelve-year stay in Holland, the Pilgrim congregation, joined by others whose motives for leaving were quite different, established a foothold on the New England coast in what is today Plymouth, Massachusetts. In the first years of the colony, the events for which they are remembered by all took place—the first Thanksgiving, the Indian Squanto teaching them how to plant corn using herring fertilizer, Myles Standish's courtship of Priscilla Mullins, and John Alden's reluctance to speak on his own behalf. Familiar paintings call to mind a band of people walking through the snow to church, blunderbusses on their backs, buckles on their shoes and hats, peering fearfully into the wilderness for some untold danger. But after the dramatic events of the colony's first few years, it is as if Plymouth had vanished from the face of the earth. For with the arrival of multitudes of Puritan immigrants into the Massachusetts Bay Colony during the 1630's, the attention of most historians shifts to events in that colony, while Plymouth to the south continues its way of seeming serenity, a cultural and historical backwater with little of interest to justify research. Yet it is this very attribute of calm, orderly cultural change in a small, rural population that makes Plymouth Colony a unique stage on which to see in microcosm many of the processes through which English culture became a very different thing, ultimately to be called American.

Today it is possible to visit the little community of Plymouth, re-created in full scale two miles south of its original site. The re-created settlement looks much as the original did to the Dutch trader Isaac de Rasieres in 1627, seven years after the arrival of the Mayflower. Shortly before the community broke out of its fortified isolation and spread over the surrounding coast and countryside, de Rasieres recorded one of only three eyewitness accounts now in existence:

"New Plymouth lies on the slope of a hill stretching east towards the sea coast, with a broad street about a cannon shot of 800 feet long leading down the hill; with a street crossing in the middle, northwards toward the rivulet and southwards toward the land. The houses are constructed of clapboards, with gardens also enclosed behind and at the sides with clapboards, so that their houses and courtyards are arranged in very good order, with a stockade against sudden attack; and at the ends of the streets there are three wooden gates. In the center, on the cross street, stands the governor's house, before which is a square stockade upon which four patereros are mounted, so as to enfilade the streets. Upon the hill they have a large square house, with a flat roof, built of thick sawn planks stayed with oak beams, upon the top of which they have six cannons, which shoot iron balls . . . and command the surrounding country."



Rendering of Plimoth Plantation today: completed re-creation will double the number of houses.



Bright colors, not somber grays, were typical of Pilgrim attire. As with most farming people, bare feet prevailed in warm weather.

The original "broad street about a cannon shot of 800 feet long" is now Leyden Street in modern Plymouth, and the cross street where once stood the governor's house and the square stockade is the location of a drug store, hardware store, electric company, and post office. But on virtually identical terrain on the Eel River to the south, the Plymouth of 1627 is now being re-created as an outdoor museum by Plimoth Plantation (the spelling was used by William Bradford in his classic history of the colony), a nonprofit, educational organization. After walking through a cool pine woods where logs are being cut and dressed as they were when the Pilgrims built their village, the "large square house, with a flat roof" appears, and stretching below it toward the sea, a narrow dirt street with small frame houses and thatched roofs gives the visitor the impression of stepping into another century.

Plimoth Plantation was founded twenty years ago to create an understanding of the Pilgrims and seventeenth-century America through exhibits, publications, films, and educational programs. In addition to the village exhibit, it also operates Mayflower II, a reproduction of the type of vessel that brought the settlers to America, as well as a typical northeastern Algonquian Indian summer encampment. But it is with the re-created village that it seeks to communicate an understanding of the way of life in Plymouth during the colony's first ten years.

The village is presented as a living community, where people perform the routine tasks involved in the life of the time. Two very important considerations underlie everything in the village exhibit. One relates to the way people tend to overinterpret the labels applied to historical periods. If the question is asked: "Is 1620, the year of the Mayflower's arrival in Plymouth, closer in time to Columbus or to the American Revolution?" most people would link the Pilgrims closer to 1775, unless they actually calculated the difference. In reality, the Pilgrims are slightly closer in time to Columbus. The result of this mental distortion of time is that the 155 years between 1620 and 1775 are lumped together indiscriminately and collectively labeled American Colonial. True, the Pilgrims did create a colony in America, but American Colonial suggests candle dipping, spinning wheels, diamond-pane windows, horn books, and a host of other things that did not exist in Plymouth during the first ten years of its existence, and in some cases not for decades to follow. Another similarly vague and

Large open fireplace, left, dominated 1627 home, where cooking gear included wood, brass, or pewter bowls. Household water, above, hauled from nearby springs, was later expediently dumped, below.

overgeneralized label is Medieval, and while it suggests King Arthur, serfs, knights, and castles to many people, the truth is that the culture of the earliest settlers in North America owed as much to its medieval heritage as it presaged the culture of colonial America a century later. The way of life brought to these shores by seventeenth-century Englishmen was one that represented a long, slow adjustment to a relatively stable natural and social environment. But once implanted in the New World, it underwent rapid change for the next century in response to the dramatically new conditions. The 1627 village exhibit attempts to convey an awareness that these people were different in many ways from their American descendants of a century later. Sometime in the course of the eighteenth century, a watershed was reached beyond which the life style became one that modern Americans can identify with on the basis of their own experience in twentieth-century America.

The second consideration in the presentation of a living 1627 village is based on current thought concerning media. Marshall MacLuhan tells us that media in modern America are changing from "hot"—very structured and linear, with a high information content—to "cool"—non-linear, with little structure

Expected to fully share the chores, child at left feeds table scraps to chickens, while tightening of breeches, far left, brings respite to boy. Children's amusements were few—perhaps a game of cat's cradle, center, or one of "make-believe" in the pumpkin patch, bottom.

and low information content and requiring the involvement of more than one of the senses to fill in the picture. In MacLuhan's terms, print is hot; television, cool. The village is also cool in media. All senses are appealed to, and structured information content is relatively low. Signs, labels, and other written information are almost nonexistent. Nothing is displayed or demonstrated simply for the sake of display or demonstration, yet by inquiring and conversing with any of the many interpreters in the village, information is easily obtained. There is no area within the village that the visitor cannot touch, handle, and experience. Live animals are present among the houses; it is not unusual to pass a chicken in a doorway or to encounter a sheep in a backyard lot. Fires are burning in all the houses, even on the hottest days, since the fireplace is the sole source of cooking heat, hot water, warmth on cool days, and frequently, light at night. It is important for a visitor to experience the discomfort of the hearth on a hot day to appreciate the problems of life in the absence of an electric or gas range, not to mention air conditioning. The smoke from the fires, the clucking and crowing of the chickens, the smell of foods cooking and of a nearby sheep pen combine to create a continuing impression of reality based on an appeal to sight, smell, touch, and hearing.

Naturalness is the key to the dress of the interpreters in the village, who wear costumes typical of the period. The Plantation's personnel can go barefoot if they desire, as have farming folk of all ages in warm weather. They might get soiled from cleaning the great iron cooking pots, carrying water, or preparing and cooking foods in the fireplaces. Visitors are somewhat surprised by the appearance of the village and its inhabitants, since it is so different from most other outdoor re-creations of the past. Yet, to create a neat, apple pie orderly community is simply not in accord with known historical fact. The problem of completeness and accuracy is a subtle and difficult one. It will never be possible to re-create everything, and were the level of realism stricter, appearances would be even more cluttered; the task is to produce reality to the point where a different life style is suggested, one quite unlike our own.

The houses are equipped with simple furniture typical of the period. Many of them do not contain bedsteads, but rather, simple pallets laid directly on the floor. There is a clutter of all the necessary equipment for survival—cooking gear, hoes, axes, bags of grain, drying vegetables and herbs, weapons, and clothing. The general impression is one of activity and life. As Marshall Davidson writes in *The American Heritage Book of Antiques:*

"At a time when, as in Plymouth and other seventeenth-century communities, the average household consisted of nine or ten people, the hall [main downstairs room] must have presented a cluttered and untidy appearance, hard to imagine from the decoratively arranged examples of such interiors . . . in most museums and other historical restorations."

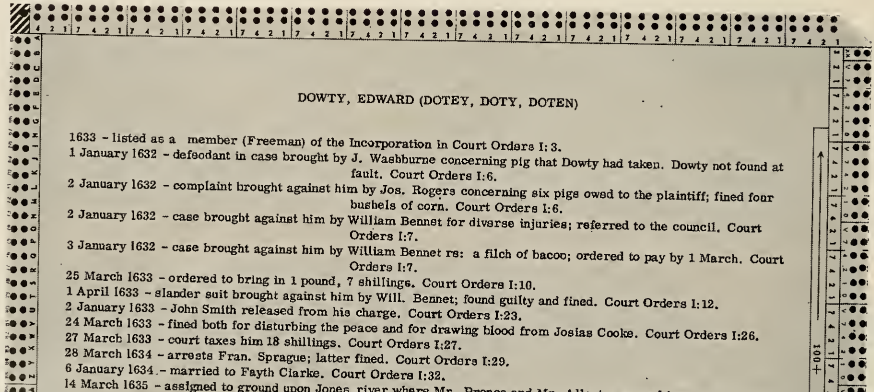
Not so at Plimoth Plantation, where the clutter is both apparent and a direct result of the kinds of tasks being done. Smelling the wood smoke, walking the dusty street, standing in a cluttered household, all contribute to the impression of entering another world—a full-size, populated, seventeenth-century time capsule.

While the physical exhibits give an impression of the tangibles of early colonial life, the all-important aspects of the culture that are not directly visible—law and government, religion, economics, social structure—are presented by the interpreters in the village. The rack of matchlock muskets in the Myles Standish house provides an excellent point from which to develop an explanation of the military practices of the time. A box of surgical instruments in the house of Samuel Fuller, the village physician, leads to the broader questions of what a doctor did, both as healer and farmer, in a simple agrarian community. The piles of clapboards, skins, and bags of corn in the common storehouse illustrate the trade that was so critical to the colony's economy during those first years.

The complexity of research that makes such a re-creation possible involves a staff of professional anthropologists, historians, and museum specialists in a varied, cross-disciplinary program. Whether data are being gathered on domesticated animals of the period to support the selection of the correct breed of cattle for the exhibits or on ceramics of seventeenth-century Plymouth for a monograph to be published by the Plantation, a broad-scale approach is taken, incorporating the analysis of contemporary documentary materials such as wills and estate inventories, of archeological assemblages from seventeenth-century housesites in the area, or of Dutch and English paintings and prints of the period for comparative information from Europe. In this way, the Plantation's research accomplishes two different, but related, purposes: the authentication of the exhibits and research aimed at publishing a wide variety of material on Plymouth Colony.

The year 1627 was chosen as a re-creation date for a number of reasons. It was in that year that the first land grants were made to individuals beyond the immediate environs of the fortified village. For the first seven years, the Pilgrims were tightly grouped within their palisade, gaining a foothold on the land, and being augmented in their numbers by other immigrants who arrived from England on at least a half-dozen ships that put in at Plymouth. These ships also brought livestock and quantities of consumable goods. Although a precise population figure is almost impossible to obtain, the total number of people in the community after seven years was between two and three hundred. Of this total, relatively few represented the original Mayflower voyagers, since half of the original 100 passengers died during the first winter. The Pilgrims had financed their movement to the New World through a joint economic venture with a group of London merchants, and until 1627, all property was held in common, and the colony benefited corporately from the fruits of its labor. This procedure has often been referred to as a form of communism. In fact, as a recent historian has appropriately remarked, the system might better be termed exploitative capitalism, since the colony's products were shipped to England for a profit through which the colony was to be supported. The joint stock company was liquidated in 1627, with the Pilgrims assuming the debt; as a result, property, including land and livestock, was divided among the various households in that year, and a census was taken, which provides the information regarding the number of families and houses at that time. De Rasieres' description of the early village also dates to 1627. Any later date would make it impossible to show a complete social community in one place, since outlying farms developed in the following years. Earlier dates from the intervening seven years have even less specific data on which to base a reasonable re-creation.

Using such information, the general demographic and physical form of the village can be approximated. However, the problem of just what kinds of houses should be built is a very complex one. Research on the subject of early Plymouth architecture must rely on data that are essentially comparative. The oldest documented house in the colony area postdates the mid-seventeenth century, and the earliest house in New England, the Fairbanks house in Dedham, Massachusetts, dates to 1636. To determine the appearance of Plymouth's earliest homes, it has been necessary to use contemporary English data from southern and eastern England, the area from which most of Plymouth's earliest settlers came; mentions of the village and houses in various records; and a comparative study of somewhat later seventeenth-century houses in the immediate area. From this composite, a prototype early Pilgrim dwelling has been designed, which can be varied in size and form to a certain degree. But



DOWTY, EDWARD (DOTEY, DOTY, DOTEN)

1633 - listed as a member (Freeman) of the Incorporation in Court Orders I: 3.
1 January 1632 - defendant in case brought by J. Washburne concerning pig that Dowty had taken. Dowty not found at fault. Court Orders I:6.
2 January 1632 - complaint brought against him by Jos. Rogers concerning six pigs owed to the plaintiff; fined four bushels of corn. Court Orders I:6.
2 January 1632 - case brought against him by William Bennet for diverse injuries; referred to the council. Court Orders I:7.
3 January 1632 - case brought against him by William Bennet re: a filch of bacon; ordered to pay by 1 March. Court Orders I:7.
25 March 1633 - ordered to bring in 1 pound, 7 shillings. Court Orders I:10.
1 April 1633 - slander suit brought against him by Will. Bennet; found guilty and fined. Court Orders I:12.
2 January 1633 - John Smith released from his charge. Court Orders I:23.
24 March 1633 - fined both for disturbing the peace and for drawing blood from Josias Cooke. Court Orders I:26.
27 March 1633 - court taxes him 18 shillings. Court Orders I:27.
28 March 1634 - arrests Fran. Sprague; latter fined. Court Orders I:29.
6 January 1634 - married to Fayth Clarke. Court Orders I:32.
14 March 1635 - assigned to ground upon Jones river where Mr. Prence and Mr. Allerton mowed last year. Court Orders I:40.
22 August 1636 - late servant of Dowty, Peter Talbott, having a portion of his land due to him has signed it over to James Skiffe. Court Orders I:43.
5 October 1636 - filed cross action with Jos. Beedle; cases referred to arbitration. Court Orders I:44.
14 January 1636 - mention of five acres in the right of Peter Talbott, for service by indenture performed to Ed Dowty. Court Orders I:47.
20 March 1636 - will mow the hay ground at Saggaquash. Court Orders I:56.
6 August 1637 - will have land at Mounts Hill if a convenient view is taken by Winslow and Jenney. Court Orders I:64.
4 December 1637 - will take Winslow, Sowther and Pratt to view a parcel of land by John Derbles grant. Court Orders I:69.

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By going through old records and recording entries on information punch cards such as the one above, Plantation researchers can determine Plymouth's population size and composition and compile a sociological dossier on each Pilgrim. The card for Edward Dowty is typical, and shows the various court actions in which he was involved. When the project is complete, the activities of some 10,000 colonists will have been collated.

the houses of 1627 Plymouth probably shared a number of basic features. They were all of frame construction, with small paper-covered windows. Chimneys were of wood, covered with wattle and daub, a wickerwork of flexible small branches amply plastered with mud. Roofs were mostly of thatch, though some could have been covered with shingles. In 1627 legislation was passed in Plymouth prohibiting the further use of thatch because of fire hazard, although the main danger seems to have been from fires that started in poorly daubed wooden chimneys and spread to the roof. Floors were dirt or wood. Floor plans were either of the single-room type, with the chimney at one end, or a two-room type with central chimney. A loft served as a storage and sleeping area.

Turning to the problem of furnishing the houses, the colony's estate inventories provide a valuable source for research. Then, as now, when an individual died, his estate was inventoried by an agent of the court and a value placed on his property, item by item. The Plantation has transcribed several hundred of these inventories from the crabbed Elizabethan script of the originals, which are still located in the Plymouth Registry of Deeds. Inventory recording did not begin until 1633, but it still offers a reliable idea of what a house of the period contained. The most striking thing about these inventories is the relative scarcity of major pieces of furniture: bedsteads, tables, chairs, cupboards are rare. The most common item of interior furniture is the chest, and it must have served many purposes—as a storage container, a seat, a worktable on which to prepare food or do any other small task, and a place from which to eat. Contemporary paintings and prints from northern Europe show chests serving in precisely the same capacity. Fireplace and cooking gear, tools, weapons, farming implements, and raw materials—leather, cloth, and food—loom large in the inventories, and it is reasonable to suggest that the most important items of property in the first ten years were those essential to provide food and shelter.

Among the earliest house inventories, that of one William Wright has been used to re-create precisely the material culture as a whole. This inventory was taken room by room, so that we not only know what Mr. Wright owned, but also in what room it was located at the time of his death. Re-created in the Winslow house, this inventory is complete to the linens in the chest in the sleeping chamber and the shoes beneath the canopied bedstead. Wright was exceptional in owning, not one, but two bedsteads, although one was located in the loft, presumably unused, while the bedding that might have gone with it was located in the room below.

The inventories, however, do not tell us anything about the physical appearance of the various items of furniture, tools, and implements. For this informa-

New thatched roof, left, took four months to build, but should last for sixty years. Thatch is Norfolk reed (Phragmites communis), *capped with cattail. Sheep, below, and other livestock are a common part of Plantation community.*

tion it becomes necessary to rely on paintings and prints of the period. The Plantation maintains a large punch card file of such pictorial material, coded according to sixty-six material culture categories. It is thus relatively easy to sort out as many examples of any type of object as are needed to determine its appearance, as well as its physical placement within a room. Archeological investigations in the colony area are also of some use in this connection, although most sites thus far excavated by the Plantation date to a somewhat later time.

Having created a village of simple frame houses, and furnished them according to the best research data available, it remains to populate the village with trained interpreters who give the appearance of seventeenth-century Pilgrims. Dress is the most conspicuous difference between the interpreter and the twentieth-century visitor, and the clothing worn is based on research into English styles of the period. The Pilgrims were a simple folk, not of the highest socioeconomic class of England. Regrettably, little study has been done on the dress of the plainer people of England of the time, so the Plantation had to commission special research projects to obtain adequate information, thus assuring proper attire for its personnel. Many people are greatly surprised by the colorful costumes. Unlike the stereotype so long associated with the Pilgrims, of people somberly clad in gray and black, they, in fact, dressed in quite bright and varying colors. In this case, the inventories again become useful, since in listing clothing, color is often mentioned. And while one does find an occasional, rather ambiguous reference to a sad-colored cloak, brighter colors generally prevail.

The material culture of the Pilgrims reflects the means by which they met the challenges of their environment. But there are also technological, social, and ideological dimensions that must be considered in presenting a full picture of early Plymouth. Within the past five years the Plantation has done intensive research on such subjects as the development of farming practices in the colony, the effect on Pilgrim culture of the years spent in Holland, relationships between the Pilgrims and Indians, deviant behavior and the courts, social structure and family life in the colony, the culture of the Wampanoag Indians of the area, the financing of the colony and its economic practices, the books in the colonists' libraries (titles are listed in the inventories), and a number of other subjects. These studies are done either by the research staff or by consulting scholars, and all have resulted in formal reports and publications. The Plantation's archeological program is typical in many ways of this kind of research. There are numerous seventeenth-century homesites still in existence, and they are being systematically investigated. A typical "Pilgrim site" is the remains of a farmhouse. There is usually some evidence on the surface of a collapsed brick chimney, and a slight depression marking location of the cellar. These sites are very rich, and it is not unusual to recover as many as 10,000 cataloged artifacts from a single house, as well as some indication of its size and

In an experiment in seventeenth-century living, a family of eight inhabited the Winslow house. On typical day they plucked feathers and cleaned pots in yard, and ate Pilgrim style—with their fingers.

ape. The cluttered aspect of the Plymouth home-eads, for example, is amply supported by archeol-gy. Scattered around the house, for a distance of veral yards, is a thick deposit of trash—broken pot-ry, animal bone, shells, nails and other structural ardware, and broken implements. One can easily nagine the state of such a house at the time—it must ave been indeed a pungent and unsanitary situation. ut the colonist's reluctance to police his yard, and to eatly dispose of his refuse, is a boon to the archeolo-ist, who gains much from the trash left behind by nese untidy husbandmen. The Plantation has exca-ated eight colonial sites in the area, and these have roduced approximately ten thousand bone frag-nents, which are now being studied for information on nimal use, butchering techniques, and diet.

Although the study is not complete, there are al-eady a few surprises evident. One is of sentimental nterest: as yet, not a single turkey bone has come to ight. Turkeys were consumed at the first Thanksgiving; while they may have been frequently hunted y the colonists, by mid-century—from which the earliest sites date—turkeys may well have become quite scarce. Even more unusual are the small numbers of wild mammalian bone from these sites. By mid-century the colonists were relying almost entirely on domesticated animals for their meat supply. How much earlier this pattern exists is not yet known, but it is possible that hunting never did contribute greatly to the table. Of the domesticated animals, the commonest is pig—not surprising when one considers the ease of keeping pigs, and the variety of easily preserved meat that these animals furnish. Cattle, sheep, and goats are also common, and one site even produced horse bones in its domestic refuse. Until mid-century, Plymouth relied heavily on cattle as a basis for its economy, trading them to the Massachusetts Bay Colony for other commodities, but of course this use of cattle would never be reflected in faunal analysis of archeological materials. Wild ducks are fairly common; in the inventories, fowling pieces far outnumber muskets. Unlike a solitary deer, a flock of sitting ducks is easily bagged by firing into its midst with a weapon that will scatter shot over a broad area.

Other common artifacts from these sites tell us of the life ways of their former occupants. Spoons occur in large numbers and knives are common. As yet no forks have come to light, and it is doubtful that they will. During the seventeenth century, the fork was a recent arrival from Italy, thought of as something only fops and dandies used. The common eating implement of the Pilgrims was the hand, and knives were used to cut food into manageable, easily handled pieces. The different types of ceramic ware found at various seventeenth-century sites dramatize the initial Americanization of the Pilgrims. Only two sites have produced significant amounts of pre-1650 pottery; one was dug by the Plantation; the other, unfortunately bulldozed away during construction of a parking lot. The early ceramics are all imported and have a strong medieval look about them—plain green- and brown-glazed pottery. English ceramic styles changed rapidly in the seventeenth century, marked by a proliferation of decorated earthenware and the tin-glazed earthenware commonly called delft. These wares occur in Plymouth Colony archeological sites of the latter half of the century and are joined by large quantities of locally produced redware. Thus an early site will have pottery that gives an impression of late medieval England, while ceramics from sites of the latter half of the century give a feeling of more of the simple, but competent, products of local craftsmen.

Archeology not only provides us with insights into the daily lives of the Plymouth colonists, but also lends support to certain aspects of their history. A small incident in Plymouth during King Philip's War (1675-76) was the so-called Eel River Massacre, at the Clark Garrison house south of Plymouth. The facts of the episode are few and simple. In the spring of 1676 a group of Indians attacked a garrison house belonging to William Clark, located on the Eel River. The attack took place on Sunday, while some of the occupants were at church. Eleven lives were lost, and the building was set afire; the Indians responsible were apprehended and executed. In 1941, archeologists excavated a homesite not far from the locale traditionally identified with the Eel River incident. While not so much as a brick had ever been turned up at the latter location, the excavated site turned out to be that of a house that stood until *ca.* 1675, and was then burned. The artifacts from the site included the normal domestic artifacts of the period, and a variety of objects that indicate some special function for the building. Large quantities of shot, as well as lead scrap and lead lumps that had cooled in the bottoms of melting ladles, were recovered. Gun flints were also manufactured on the site, as indicated by massive amounts of waste flakes of English flint. Parts of a military uniform, a fragment of an epaulet, and a boot tap were found. The conclusion in this case seems quite obvious, and provides further documentation of a historical event.

A totally pragmatic approach added another dimension to the village presentation, when several of the houses were used experimentally in a genuine living situation. In the house furnished according to the Wright inventory, for example, a family of eight lived for a week according to seventeenth-century ground rules. The project was an experiment in determining whether this method would provide any greater insights into how to present all the houses in the village. It has succeeded to the extent that the Plantation staff is now convinced that a much greater amount of this kind of investigation should be pursued. One striking result was the pattern of clutter and debris that comes from full-time living, day and night, over a sustained period of time. It is very difficult to simulate clutter, unless it is done by actually engaging in the activities that produce it. After carrying water, chopping wood, and preparing the food necessary to sustain eight people, certain patterns of use became apparent. The constant supply of water needed at the hearth insured a rather damp area in the line from door to fire. Problems of disposal of purely natural refuse became very obvious; one must do something with all the cornhusks, bone scraps, onion peels, and clamshells that accumulate. Taking note of the archeological evidence for dumping refuse in the yard, it was tried, and while a certain amount of debris did remain, the ever present chickens consumed a surprising amount. Were pigs to be added to the roster of live dispose-alls, the problem would be even less serious.

At a time when man has just set foot upon the moon, and technology promises to dominate our society, it is somehow reassuring to look back to another era, when problems, although just as serious, were at least somewhat more at one's immediate disposal. There is a strong feeling in the nation today of a loss of individuality, of control over one's social destiny. Attempts are being made, some successful, some not, to return to earlier standards; to an earlier style of living. In placing our colonial ancestors in their proper perspective, at least one can hope to learn if the lost world we are mourning did once exist. It is strange, indeed, that many Americans invoke values in the name of the country's founding fathers, including the Pilgrims, that these men of the past would find somewhat peculiar. Some of the dissent that has recently disturbed much of the nation is not essentially dissimilar from that which caused our first settlers to remove themselves from familiar ways and set out into an unknown world. It matters little, in fact, whether Myles Standish ever spoke more than three words to Priscilla Mullins—he may not have—but it matters greatly if the Pilgrims are considered to have established religious freedom in the New World—they did not. But there is much to respect, admire, and appreciate, from our three-century perspective, in what and who these people truly were, and it is through Plimoth Plantation's efforts, along with those of historians and anthropologists concerned with seventeenth-century America, that the story of the Pilgrims and their fellow colonists can be told "like it was."

The doorway of the Miles Standish house frames a mist-shrouded view of John Alden's yard and beyond.

SKY REPORTER

STARQUAKE ON PSR 0833-45 Just a year after discovery, the pieces of the pulsar puzzle seemed to be falling into place early this year. So astronomers were jolted (a common happening in the last decade) when a pulsar in the southern sky suddenly broke their brand new rules. It had only recently been found that the pulse rate of all pulsars was slowing down in regular fashion. Extrapolations into the past and the future were confidently made from observed rates. Then PSR 0833-45 (located in the sky at right ascension 8 hours 33 minutes, declination minus 45 degrees) suddenly spurted ahead, only to slow down again in the accustomed fashion. Theorists reached for their chalk.

A New York University physicist, Malvin Ruderman, proposes a solution (in a recent issue of *Nature*, the British science journal) that allows for the sudden spurt while retaining the conventional explanation that pulsars are rapidly spinning neutron stars. As he sees it, when neutron stars first form they spin rapidly; they also develop a crust (in a neutron star with a mass about that of the sun, the crust would be about 200 yards thick). The crust forms rapidly at a time when the star is spinning so fast it has an oblate shape like Jupiter's; the crust could be said to freeze in this shape. As the star's spin slows down, however, gravitational force tends to pull the star into a sphere. The crust experiences greater and greater stress until it finally fractures and slips into its new shape. Being more compact, the star now spins slightly faster.

The gravitational force of a neutron star is so strong that the shape distortion locked into the crust is no more than an inch; removal of this anomaly by the starquake, however, would enable the star to spin faster, cutting almost exactly the observed 100 billionths of a second from its rotation period.

REPORT FROM MARS The hope that some form of life will be found on Mars is still alive as scientists work and rework data sent back by Mariners 6 and 7 after their midsummer fly-by. Some rugged plant life may survive the planet's intense cold, lack of water, ultrathin atmosphere, and exposure to lethal ultraviolet radiation.

Interest centered briefly this fall on the south polar cap, where traces of ammonia and methane—gases often, but not always, associated with life—were thought to have been detected. That report proved false. But this same area appeared to have an umbrella of haze, possibly carbon dioxide crystals, that could filter out the ultraviolet photons streaming in from the sun. The argument over whether the polar cap is frozen water or carbon dioxide was not immediately settled, and the evidence favored carbon dioxide.

The two probes provided plenty of new fuel for argument. Ultraviolet scanners analyzed the upper atmosphere. Infrared instruments measured temperatures. Radio signals passed through the Martian atmosphere revealed something of its density and structure. Best of all, the spacecraft returned 200 medium- and high-resolution pictures, some of them showing features as small as 300 yards across. All this should be more than enough to keep everybody busy until two more capsules orbit the planet in 1971.

While no major surprises turned up, plenty of new questions arose. Why is the bright area known as Hellas devoid of the craters that otherwise cover the planet?

What are the clouds, which in earthbound telescopes appear to form the letter *w*, that brighten each Martian afternoon in the Tharsis-Candor area? Is it possible they mark the location of hot springs?

What are the looping, tangled white streaks around the 300-mile-wide crater Nix Olympicus? Why does Nix Olympicus itself brighten each afternoon?

Scientists at the Jet Propulsion Laboratory in Pasadena, working with prints just out of the darkroom, are already marking off the days to 1971.

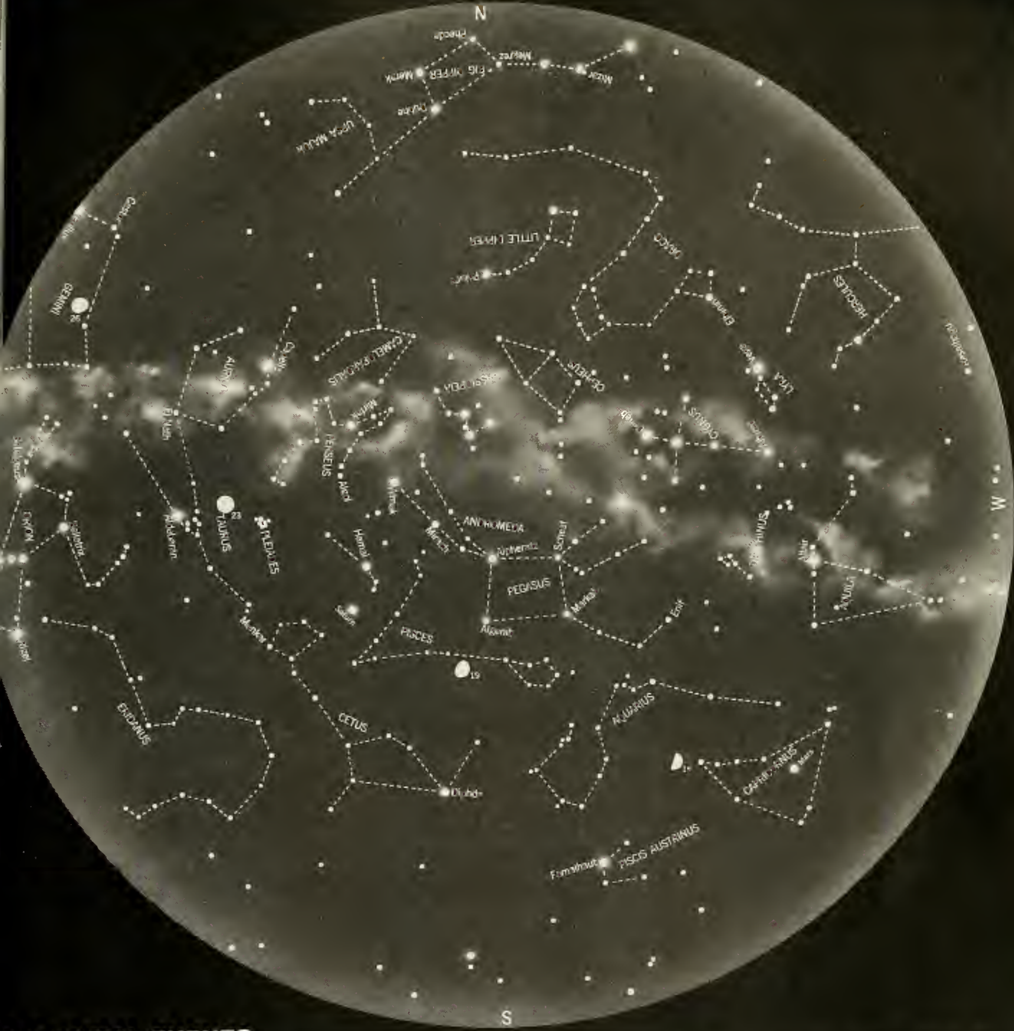
QUASAR CLOSE TO HOME Hard on the heels of the discovery of extraordinary infrared radiation from the nucleus of our galaxy comes a theory to account for it: a dead quasar at the center, detectable only by the attraction it exerts on other matter and the resulting radiation.

Donald Lynden-Bell of the Royal Greenwich Observatory, writing in the British journal *Nature*, starts with the assumption that quasars were common during the first billion years the universe existed, but that their average life is only a million years. He then takes the estimate of Allan R. Sandage of Mount Palomar that there are today 10 million quasars visible in the sky. Because only one in a thousand is burning at any one time, he comes up with the number 10 billion (nearly all dead) for the total number in the universe. He then computes the density per unit volume and finds the average distance between all quasars to be some 10 million light-years. This number would make it probable that a quasar (probably dead) lies within the local group of galaxies.

If there is one, how do you find it? Current theory has it that when a quasar burns itself out, the central portion collapses and becomes so dense that no radiation of any kind can escape: it will disappear from the visible universe. Its gravitational effects would still be felt, however; it would be expected to be at the center of a concentration of mass—such as our galaxy. Gas at the galactic center would continuously fall through this "hole" in space; collisions among particles in this whirlpool of gas would generate enough heat to account for the infrared radiation we observe.

How did the quasar get there? Commenting on the Lynden-Bell paper, *Nature* suggests that quasars may form when a galaxy is condensing out of an initial cloud of gas as a sort of "superstar" at the center. The quasar would have burned out and collapsed by the time star formation was well along in the rest of the galaxy.

JOHN P. WILEY, JR.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Phecda
Megrez
BIG DIPPER
Merak
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URSA MAJOR
Castor
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Polaris
DRACO
GEMINI
26
HERCULES
CAMELOPARDALIS
Capella
AURIGA
CASSIOPEIA
CEPHEUS
Eltanin
Vega
LYRA
Deneb
CYGNUS
Mirfak
El Nath
PERSEUS
Algol
Betelgeuse
ORION
Bellatrix
Aldebaran
23
TAURUS
PLEIADES
Hamal
Mirach
ANDROMEDA
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ERIDANUS
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CELESTIAL EVENTS

The moon is in the morning sky early in November, with last-quarter on the 2nd. New moon occurs on the 9th, and the moon then enters the evening sky. First-quarter is on the 16th and full moon on the 23rd.

Mars and Saturn are evening stars; Mars in the south at dusk and Saturn rising in the east. Venus and Jupiter are morning stars, quite close in the eastern sky early in the month, then separating as Jupiter rises earlier during the month.

November 3: Venus and Jupiter are close in this morning's sky, rising about an hour before the sun. Venus is the brighter planet. The star below the two planets is Spica, in Virgo.

November 5: The weak Taurid meteor shower reaches maximum, but only about 15 meteors per hour are usually recorded by the single observer.

November 8: The very slim crescent moon joins Venus and Jupiter in the sky this morning. Both planets are to the north of the moon.

November 14-15: Mars is near the crescent moon on both evenings, to the left and above on the 14th, to the right and lower on the 15th.

November 16: Mercury is at superior conjunction, in line with, and beyond, the sun in our sky.

November 17: The Leonid meteor shower reaches maximum, and no moonlight will interfere with observations during morning hours. While not usually a rich shower (only about 25 meteors per hour at maximum), it is famous for swift, bright meteors.

November 21: Saturn is the bright object near the brilliant moon tonight.

THOMAS D. NICHOLSON

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 9:15 P.M. on November 1; 8:20 P.M. on the 15th; and 7:20 P.M. on the 30th; but it may be used for about an hour before and after those times.

The Ecology of a Reservoir

The life processes that change polluted, undrinkable stream discharge into clear, fresh drinking water remain obscure. But clues to the complex systems governing the major source of potable water for urban man are emerging, as shown in this study of Quabbin Reservoir in Massachusetts.

by Paul A. Erickson
and John T. Reynolds

When most people think of bacteria, they think of diseases. They might therefore consider that Albert Schweitzer was carrying "reverence for life" too far when this philosophic medical missionary applied his tolerance to the bacterial world. But one need not be a philosopher to have high regard for these ancient wonders of the microcosm. One need only be: (1) a bit thirsty and (2) inquisitive about the natural processes that provide us with clean drinking water.

Of course, to many of us a reservoir—that intricate ecological system from which we draw our precious water—exists only as "the other end of the faucet." Or perhaps it is a scenic view beyond the pines on a deserted way. In either case, it is usually thought of as a healthy reservoir only in terms of bacteria being absent. Yet, should the faucet someday run dry or the scenic view become a blight, the reason might conceivably be found in a simple fact: bacteria, necessary to the reservoir's well-being, had ceased to do their work effectively.

The problem of maintaining our reservoirs in a healthy condition is quickly assuming major proportions in our society. Microscopic plants known as algae, which can compete with some forms of bacteria for essential nutrient, are the most common cause of public concern, and their presence in large numbers is usually used by the scientist as an indicator that all is not well with a reservoir, that it is growing old and senile. Foul odors and taste in drinking water supplies, clogged filters in water treatment plants, increased costs of water treatment, grossly impaired appearance of valuable lakes, depletion of dissolved oxygen in water (and therefore the depletion of important fish populations), and greatly diminished land values—these are but a few consequences of

the growth of large numbers of algae and the senility of water. They are sufficient, however, to warn us that our own physical, economic, recreational, and even esthetic lives are intricately bound up with microbiological processes that govern the life and death of our reservoirs.

In spite of our vital dependence upon these microbiological processes, it is recorded by the United States Department of Health, Education and Welfare, in a publication devoted to the significance of algae in water supplies, that "studies or attempts to control algal problems in water works have revealed hit-or-miss procedures, little coordination of effort, and only occasional systematic recording of essential data." This criticism of man's efforts to understand and control his environment was made in 1962. In 1965, one attempt at the necessary "systematic recording of essential data" on the interdependent roles played by bacteria and algae in the life processes of reservoirs was begun in Quabbin, a reservoir of special significance to the citizens of Massachusetts.

Completed in 1937, Quabbin Reservoir is approximately 60 miles west of Boston. It is a man-made, 18-mile-long reservoir, created in the Pioneer Valley area by damming up three branches of the Swift River and more than a dozen "Walden-type" ponds so characteristic of the New England landscape. The plan for Quabbin, first conceived in 1895, eventually called for the complete destruction of the towns of Dana, Enfield, and Greenwich; the partial destruction of the towns of Salem and Prescott; the displacement of 2,500 citizens; the clearing and burning of trees and shrubs over approximately 38 square miles of farm and woodland; and the reburial of more than 7,000 bodies from 34 cemeteries. The reservoir began to fill in 1939 and reached its maximum capacity of 412 billion gallons in 1946. Because of a recent drought in the northeastern states, this vital water resource fell to 50 percent of its capacity in 1966, but it has since risen to about 60 percent of capacity.

Predictions as to how long it will take for Quabbin to refill are admittedly pure guesswork. Nevertheless, thirty-one municipalities of the greater Boston area still depend upon Quabbin as their basic water supply. Several lesser reservoirs in Massachusetts and their associated water treatment plants are maintained at adequate levels only by aqueduct diversions of water emanating from Quabbin. In the summer season alone the output of clean water from this reservoir can exceed 10 billion gallons per month. Obviously, the importance to man of the aging of water is directly proportionate to the importance of the water in which it takes place. Hence the significance of studies concerning eutrophication in a reservoir as important as Quabbin.

In the waters of such a reservoir there are complex, dynamic interactions of physical, chemical, and biological factors. These act over time to minimize the accumulation of free organic material in the stored water. Such organic material is always present, since much of it comes from the cellular debris of algae that live and die in the reservoir. But algae are not the only source. Other organisms and organic materials—such as leaves, commercial fertilizers, pesticides, and dead animals—are continually introduced into the reservoir by wind, stream, animals, and, of course, by man.

A significant portion of all organic material found suspended in the water or in the muck at the bottom of a reservoir, whether that material originated within the reservoir or outside of it, is cellulose. Cellulose is a complex chemical compound found in the cell walls of most plants. It is of special significance because it is not easily degraded, or transformed, into less complex compounds. Man, for example, excretes most of the cellulose that he ingests when he eats a celery stalk because his digestive system cannot break this molecule into smaller pieces. But if the cellulose in a reservoir were not degraded in some fashion, it would go on accumulating until, much like a municipal dump overflowing the city, it replaced the water.

The cellulolytic bacteria are among the few organisms present in the depths of a reservoir's waters that can accomplish this necessary degradation. Meanwhile, various other bacteria decompose the remaining non-cellulose debris.

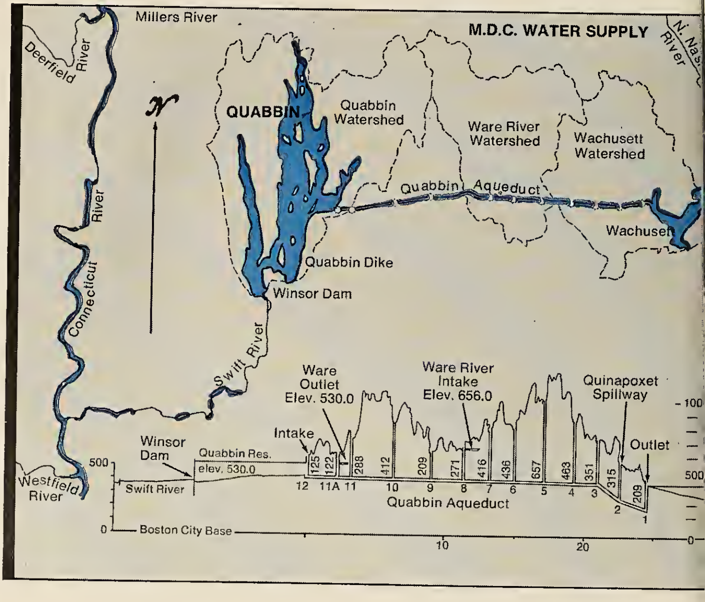
That bacteria can accomplish the decomposition of organic material that settles on the reservoir bottom would seem to obviate any fears that the reservoir must quickly choke itself with debris. But, in fact, this decomposition ushers in even more immediate threats to the life of the reservoir. Just as microorganisms present within the specialized stomachs of cows, rabbits, and sheep digest the cellulose of grass and leaf, thereby providing these animals with essential nutrients, bacteria working within the bowels of a reservoir release into the overlaying waters equally significant nutrients. In turn, these nutrients are largely taken up by those very algae that increase in number by feeding on the rich chemical feed. When these microscopic organisms die and settle to the bottom of the reservoir, the decomposition cycle begins all over again. Thus, year by year, the water becomes increasingly unfit for human use.

To be sure, there are ecological situations where the uptake of nutrients by algae is proving useful to man. An example is South Africa, where water resources are severely limited. There, sewage, rich in nutrients released upon bacterial decomposition of fecal material, is inoculated with algae. These grow quickly by removing nitrogenous compounds from the sewage. The enhanced algal growth, which appears as a green slime and is commonly called "an algal bloom," therefore frees sewage water of those chemicals detrimental to man and facilitates the direct recycling of such water back into human consumption.

However, when our aim is not to purify sewage but to maintain the purity of reservoirs, the uptake of nutrients by algae—far from being a blessing—is a clear and ever present threat. Here the situation is best described in terms of a delicate balance between those forces that would solidly clog the reservoir with organic debris, and those that would increase its algal populations to undesirable levels through a bacteriological removal of that debris.

Such delicate balances are characteristic of all ecological systems and are known by the biologist as "moving equilibria." These are "moving" balances in the same sense that, while a seesaw is in "stationary" balance when two boys of equal weight are sitting on opposite ends, the balance "moves" and the board tips if a third boy jumps on at one end. In similar fashion the balance characteristic of any ecological system is continually being struck and lost and gained again for the simple reason that organisms, along with their individual nutritional requirements and products, are continually being added to, and subtracted from, the environment. When the ecological system with which we are dealing is a reservoir, we are most interested, of course, in maintaining the specific and certainly delicate balance that is most beneficial to our human needs.

The shift of this equilibrium, or



balance, in a reservoir over time is referred to as the aging process of that reservoir. In terms of ponds, the "aged" (or eutrophic) pond is a body of water with such an accumulation of organic material that the bacterial degradation of that material, plus nutrients arriving from the watershed, makes a great variety of nutrients available for the support of larger populations of more complex forms of plant life. In the "young" (or oligotrophic) pond, on the other hand, the continual deposition and degradation of organic debris proceeds so slowly that large algal populations and emergent plant forms, such as water lilies and cattails, cannot exist. Every oligotrophic pond eventually becomes eutrophic, just as surely as every one of us must grow older. But unlike man, whose lifetime has been increased by modern technology, the lifetime of a pond or reservoir has been drastically shortened by that same technology. Before the advent of technological man and his power to pollute, the lifetime of a body of water could be measured in thousands of years. Today, man's demands for clean water are ever increasing. Yet he introduces into the atmosphere and water materials that serve as nutrients for algae—and an oligotrophic lake can become senile and die within a decade.

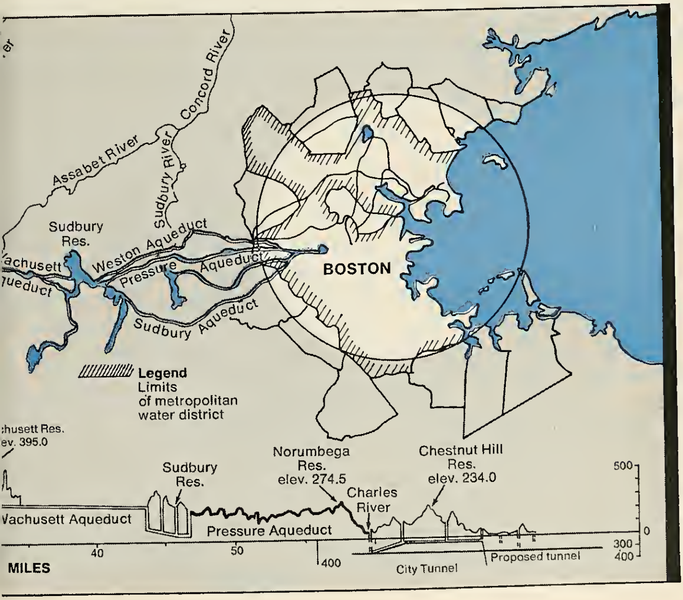
It is, regrettably, a simple fact of life that we cannot as yet stop or reverse the eutrophication process going on in our water resources. Therefore the people responsible for maintaining adequate supplies of clean drinking water, such as those at Quabbin, are primarily interested in techniques designed to slow down that aging process. A number of these techniques are based upon the following procedures, either singly or in various combinations. There are many other procedures, of course, but these eight are deemed most applicable for the long-term control of eutrophication in established reservoirs. They call for:

1. Reduction of nutrients introduced into the reservoir. This is done through strict control and surveillance of sewage waste disposal and chemical fertilizers, which could leach into waters draining into the watershed of the reservoir.
2. Reduction of nutrients released into overlaying water by bacterial decomposition of bottom sediments. The nutrients are held back by the human deposition of a non-organic, inert "covering layer" on top of those sediments.
3. Reduction of algal populations by mechanically harvesting the algal crops. (This reduces the amount of nutrients released upon their decomposition.)
4. Reduction of organic deposits on the reservoir bottom. This is done by mechanically harvesting rooted and blossoming plants.
5. Removal of organic deposits on the reservoir bottom by dredging.
6. Removal of dissolved nutrients from water by the use of physical and chemical agents.
7. Removal of algal populations by chemical agents.
8. Reduction of the algal population by stimulating an increase in the fish life that feeds upon those populations.

While each technique offers some hope that the steady progress of eutrophication might at least be temporarily thwarted, none is yet integrated into programs considered universally practicable and efficient for the continual day-to-day depression of that process in our reservoirs. One reason for this situation is that many of the techniques are still in the experimental stage. It could well happen, for example, that dredging a reservoir's bottom muck would be too drastic an operation—stirring up the muck might increase the amount of nutrients dissolved in the water. The same result might come from mechanically uprooting plants on the reservoir bottom.

Also, the various procedures have not yet been incorporated into a workable program because even if they should prove scientifically possible, the financial and physical problems associated with their actual application are so immense as to make them, for now, impracticable. For example, even if we knew precisely which nutrients to extract from the water, and even if we had the materials and techniques necessary for that extraction, could such techniques be realistically applied, say, to more than 400 billion gallons of water in a single reservoir? To develop procedures out of studies conducted on small "laboratory ponds" is one thing; to apply them to large reservoirs is another.

Algicides such as copper sulfate are often employed in the effective



control of algae in water supplies. The effectiveness of these chemical agents, however, depends upon a number of factors: the density of the algal populations, the specific kinds of algae present, the alkalinity of the water, and the amount of organic material suspended in the water. Their use, therefore, requires continual chemical and microbiological monitoring of the reservoir. Such monitoring, given the availability of trained personnel and facilities, is not always possible.

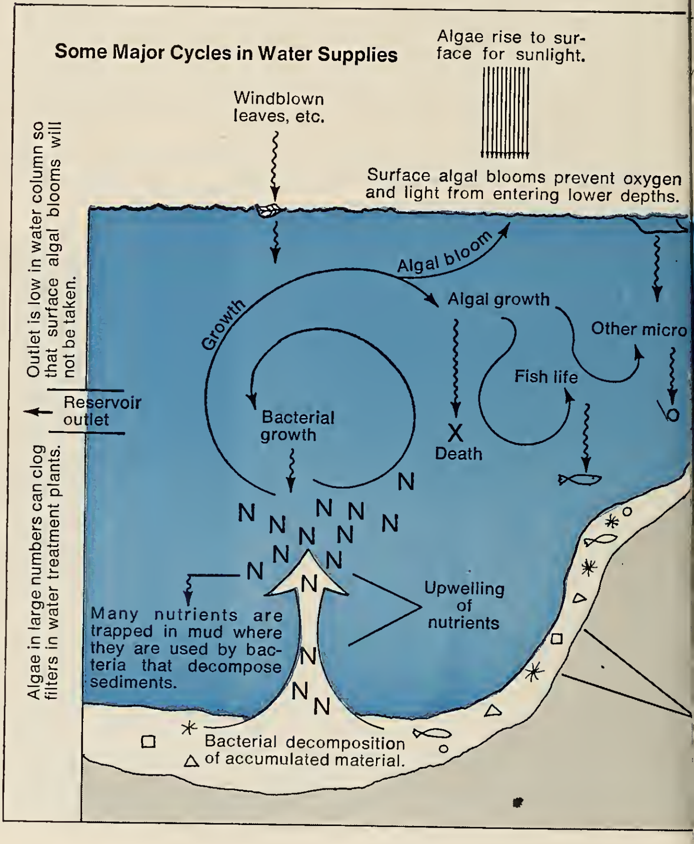
Finally, and perhaps most importantly, it must be remembered that a reservoir is not just a body of clean drinking water put aside by society for the communal good. More realistically, a reservoir is also a focus of sociopolitical factors that must be taken into account when designing any procedure aimed at the control of eutrophication. One has only to think about the public fury generated on both sides of the fluoridation question, for example, to understand a fundamental point about water resources and methods (both current and proposed) for their preservation: the deeper the reservoir, the more complex and strong are its sociopolitical currents. This is not so much an idealistic criticism, as it is a mere observation that the ecological system of a reservoir includes our own sociology. If it is scientifically possible to dredge a reservoir, for example, is it sociologically wise to "dirty up" a fisherman's favorite lake? If it is scientifically feasible to reduce nutrient levels in a reservoir by strict surveillance of sewage disposal and fertilizer use in areas surrounding a reservoir, is it politically possible to do so? These are obviously questions that the biologist and the engineer cannot answer—but it is often within the framework of just this kind of question that their proposals must be built.

It is because of such complexities that one other possibility for slowing down eutrophication in our reservoirs is of particular interest today. It concerns the unique studies, classified under the general heading of "microbial intervention," and initiated under the direction of the Water Resources Research Council of the University of Massachusetts, that began at Quabbin in 1966 and are still in progress.

The rationale behind such studies can be simply stated: if the ecosystem of the reservoir could be so managed as to favor those groups of bacteria that already compete with algae for the nutrients derived from decomposed organic sediments, the algal food chain would be broken. Therefore algal populations of undesirable proportions could not occur. Such microbial intervention is significant because it would maximize the reservoir's self-cleansing capability—a capability that seems to have been quite sufficient up until the time of "Homo pollutans." If it could be sufficiently maximized for today's needs, microbial intervention would tend to soothe the political and social pulse. For it is, after all, a "natural process."

What is needed, however, before we can construct and implement any procedure founded upon the rationale of microbial intervention—or any other procedure for checking the eutrophication process—is precise information describing the interactions of algal and bacterial populations over time in our reservoirs. We have already learned, for example, that Quabbin Reservoir may be subdivided into several areas, each with a unique microbial ecology. To illustrate, the number of algae in water samples from one area of Quabbin is such that the water has a distinct greenish-brown color, while the algal population in another area is often only one-tenth as great, and the water is crystal clear. And we know that the kinds of algae indigenous to one area are not necessarily the same kinds present in other areas.

Some Major Cycles in Water Supplies


Algae rise to surface for sunlight.
Windblown leaves, etc.
Surface algal blooms prevent oxygen and light from entering lower depths.
Outlet is low in water column so that surface algal blooms will not be taken.
Algal bloom
Algal growth
Growth
Other micro
Fish life
Reservoir outlet
Bacterial growth
X Death
Algae in large numbers can clog filters in water treatment plants.
N
Upwelling of nutrients
Many nutrients are trapped in mud where they are used by bacteria that decompose sediments.
Bacterial decomposition of accumulated material.

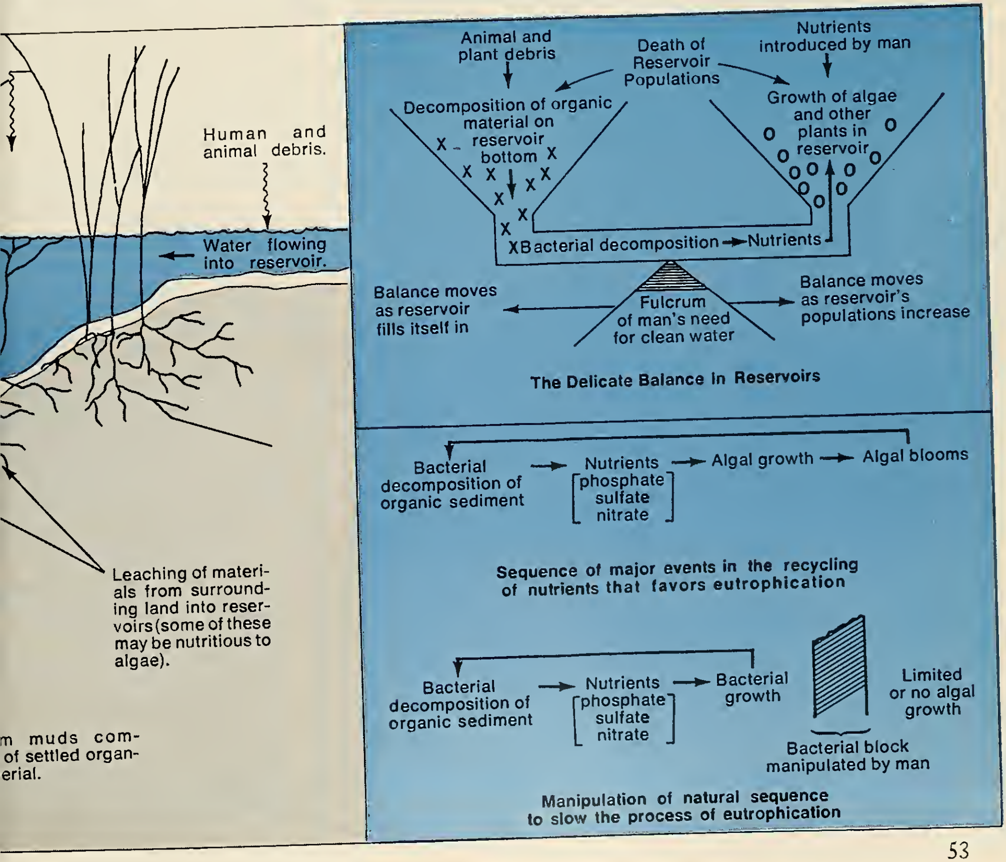
But we also know that when algal opulations increase in Quabbin. acterial populations generally derease. This brings up the important uestion, "Why?" It remains unanwered, as yet, but only through a ontinual collection of this kind of nformation are we able to ask such uestions at all—questions that perain directly to the problem of eutrohication and that are therefore cenral to the future formulation of nethods that will effectively deal ith the problem.

In the period of time Quabbin has een under study, hundreds of galons of water have been collected. iltered, and tested, and their conents have been examined under the nicroscope. In the same period of ime, billions of gallons of that same vater have been poured into millions of drinking glasses in hundreds of thousands of homes in the heart of Massachusetts.

That water comes into Quabbin undrinkable. It stays there, according to some estimates. for up to three years, and finally leaves Quabbin crystal clear. Exactly how this feat is accomplished remains a mystery. But more than that, as long as the mystery remains, we demonstrate that we still know too little about Quabbin's total ecology; we remain in serious danger that those same processes of self-cleansing shall become disrupted by the eutrophication process and result in the death of the reservoir.

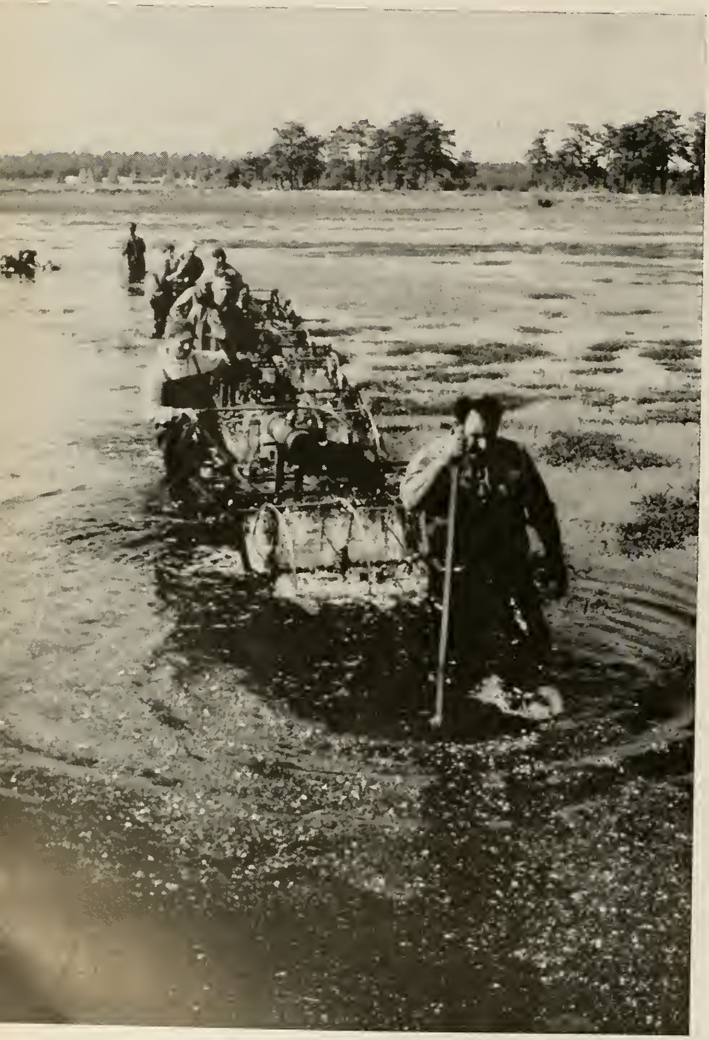
That we have as yet no practical methods for bringing about an effective slowing down or reversal of that aging process is perhaps disappointing and definitely alarming. But it should not be surprising. We have crawled out from our caves to add cruelly to the burden of an ecological system geared to its own cleansing before we have fully understood the basic microbiological processes by which that cleansing is carried on. If we are now to keep our reservoirs alive we must inquire before we can hope to dictate: we must understand natural mechanisms precisely before we can manipulate them according to our own human requirements.

But even now, have we really turned away from those dark primordial cavern walls where we trace our own smudged effigies in a vain effort to trap the natural world in a human wish? That question will remain as long as we are preoccupied with bacteria as destroyers of human life and know so little about them as vital links in the process by which nature provides clean water.


Human and animal debris.
Water flowing into reservoir.
Leaching of materials from surrounding land into reservoirs (some of these may be nutritious to algae).
m muds com- of settled organ- erial.
Animal and plant debris
Death of Reservoir Populations
Nutrients introduced by man
Decomposition of organic material on reservoir bottom
Growth of algae and other plants in reservoir
Bacterial decomposition
Nutrients
Balance moves as reservoir fills itself in
Fulcrum of man's need for clean water
Balance moves as reservoir's populations increase
The Delicate Balance In Reservoirs
Bacterial decomposition of organic sediment
Nutrients phosphate sulfate nitrate
Algal growth
Algal blooms
Sequence of major events in the recycling of nutrients that favors eutrophication
Bacterial decomposition of organic sediment
Nutrients phosphate sulfate nitrate
Bacterial growth
Limited or no algal growth
Bacterial block manipulated by man
Manipulation of natural sequence to slow the process of eutrophication

CRANBERRY HARVEST

photographs by David A. Caccia



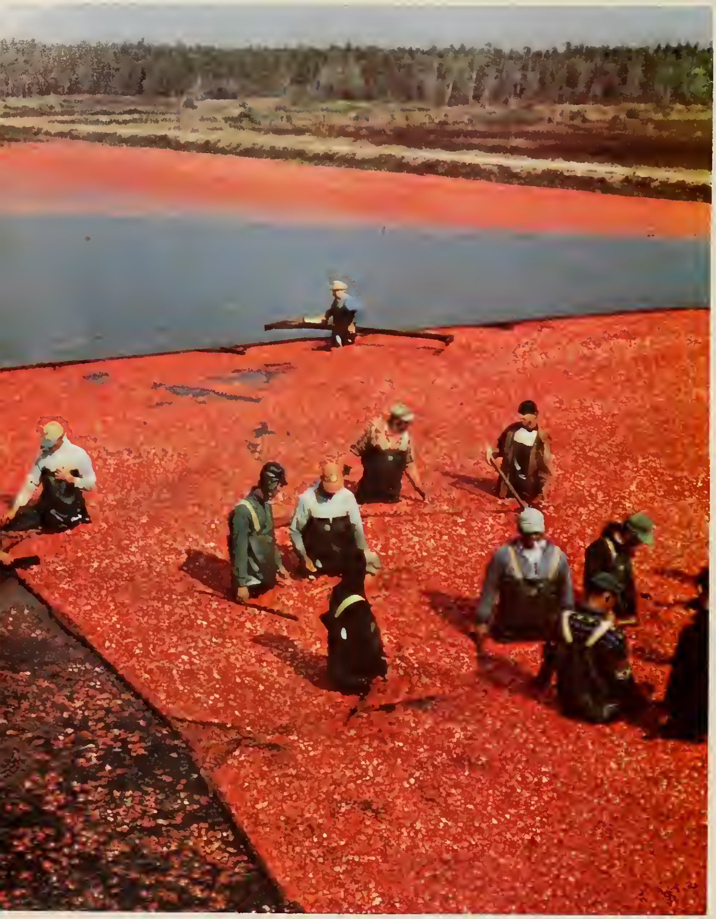
Harvest begins: motorized flails detach cranberries.

Along New Jersey's coastal plain, the sandy, acid soil would not grow crops for the early settlers. So they called the region the Pine Barrens, in wry tribute to its predominant trees: the scrubby, frequently burned pitch pines. Beneath the pines grew interesting little plants that could thrive in the dry, sandy soil—teaberry, blueberry, pixie moss.

However, this region of virtual wilderness exhibits not one, but two ecologies. Through it run many streams, including small rivers, and these account for a second kind of acid-soil environment. Here the characteristic tree is the southern white cedar. Since little sunlight penetrates a cedar swamp, the undergrowth is mainly sphagnum moss, which forms a solid carpet at the base of the trees. But at the edges of the cedar swamps and along the stream banks flourish some of the most interesting of the Pine Barren plants. Among these can be found many species of orchids. The cranberry, *Vaccinium macrocarpon*, a trailing evergreen shrub, also grows in this region.

Originally, its familiar large berries (one-half inch in diameter) were gathered from wild plants growing in swamps and marshes. Then came cultivation. Because the plants require special conditions of moisture, soil structure, and acidity, traditional upland farming is unsuitable, but many acres in the Pine Barrens are excellent cranberry lands. as are many regions in Massachusetts. The berries are grown in bogs made for them. First, native vegetation is removed from a naturally swampy area, often by flooding it for two or

The creeping plants remain submerged in flooded bog as harvesters guide the raftlike layer of floating berries.



The raft nears operational end of the bog,
where its berries are maneuvered to the conveyor belt.

three years. A dike built around the area retains the water, which usually comes from a stream that has been dammed to provide a reservoir—cranberry culture depends on large quantities of pure water. New plantings are started from cuttings, and a bog can produce crops for a century or more if given proper attention.

During the growing season, moisture should always be available to the plants, but they will not prosper if they are flooded continuously. A system of ditches serves to keep the water level suitably below surface.

Although a hardy plant, the evergreen cranberry is susceptible to winterkill when the ground is frozen and there is a high wind. The wind can dry the plant, and frozen roots cannot replace the needed water. Therefore the bogs are kept flooded from December until April or May, a measure that also prevents injury from spring frost.

In addition, hives of bees are placed throughout the bogs in mid-June to ensure complete pollination of the blooming plants. Finally, there is a spraying program for insect-control.

When berries ripen early in September, the bogs are flooded again, causing the summer population of mice, muskrats, and snakes to swim to higher ground. After the water is a foot or so deep, workers wade into the bog with motorized flails. These detach the fruit, which rises to the surface, and the bog now looks like a red sea of floating berries. A sluice gate opened at one end of the bog permits the berries to float to a collection point, but men are sometimes employed to propel the raftlike layer of berries along. A series of motorized conveyors then moves the crop into trucks for transport to the processing plant. Damaged berries are removed, and the remainder then travel on to gratify the American consumer's taste for the cranberry.

ESCALANTE CANYON

A walk through a stream-sculptured wilderness in the desert of southern Utah.

by Edward Abbey   photographs by Philip Hyde

The Escalante is a small river that flows from the gh plateaus of south-central Utah into what was ce the Colorado River, now the reservoir called ake Powell. In the course of its final sixty miles the scalante has carved a meandering, deeply entrenched nyon through the monolithic sandstone that overlays ost of the region. This river is the living heart of a oadless canyon system, which is the best that now emains of the former Glen Canyon wilderness. Like the tter before its submergence under the waters of the an-made lake, the Escalante and its side canyons ontain a variety of bridges and arches, seeps, springs, treams, and waterfalls, secret garden alcoves and owering slickrock walls—a peculiar combination of atural features that cannot be found anywhere else, o far as I know, but in the canyonlands of the olorado Plateau.

One day last spring I went for a walk down into the ower end of the Escalante and its tributaries. Leaving my car at the head of Hurricane Wash, some forty miles southeast of the town of Escalante, I tramped down the wash toward the semisubterranean world of the canyons. On my back I carried a light sleeping bag, enough dried food for three days, and a gallon of water, plus such miscellaneous (but indispensable) items as matches, a notebook, and old tennis shoes.

The trail begins by following an old jeep track (a rancher's dead-end road) for a couple of miles; then the track diverges onto high ground while the trail continues in the sandy, descending bed of the wash. The way was well trodden by the hooves of many cattle—the property of local ranchers—and not a few hikers, even by the wheels, I sadly noted, of a motorbike. This is primitive country, not a pristine wilderness, and it has already begun to attract hikers and campers from all over the nation. As I saw by the scratchings on a slab of sandstone, a whole troop of Boy Scouts had passed this way only a year before. (I should mention that Hurricane Wash is the easiest and most popular entryway to the Escalante; its other side canyons are seldom entered.)

Gradually the wash deepens, becomes what in most parts of the West would be called a canyon. The buff-colored sandstone walls rise almost vertically on either side, unscalable, for the most part, except with climbing equipment. There is some plant life, but not much; the canyon floor consists of waterless sand and little else. The walls close in and for the distance of a crosstown Manhattan block I marched through a corridor of nothing but sand and sandstone: lifeless, a deep narrow channel of architectural symmetry in the rock, scoured so vigorously by occasional summer floods that no plant of any kind has been able to take root. The corridor is about eight feet wide, about thirty or forty feet deep; to be caught here during a flood would be fatal.

Then the canyon broadens as it deepens. The first signs of water appear: wet sand, mudbanks, swaths of pickleweed and wire grass, clumps of willow. And deer prints and cliff rose, cow dung and flies. Dried algae on the rocks, tiny, stagnant pools alive with water skippers, dragonflies hovering above and swarms of mosquito larvae within. In a deep-shaded undercurve of the wall I came to the first seep and a perceptibly flowing rill of water. One could drink here, if necessary, although the water is polluted by the infestation of cattle. I trudged on without pausing; although hot and thirsty, I had the four quarts of water in my pack still untouched. Besides, I wanted to see how far I could go in comparative comfort without a drink. In this way I'd find out how much water I would need for the hike out, back to the car.

Deeper and deeper the bed of Hurricane Wash cuts into the bedrock; the walls become several hundred feet high, much higher than the canyon is wide. The series of pools join one another, forming a trickling flow that oozes over the rock and mud and sand. I passed a few cottonwood trees, growing tall and slender in this deep, shadowy canyon. More thickets of willow and tamarisk, many tracks of deer, cattle, and smaller beasts. From somewhere ahead, around a bend in the canyon, I could hear the alluring sound of running water. I hurried on, turned the corner, and saw that the canyon I'd been following now joined a much bigger canyon. Here were beaches of sand, groves of giant cottonwoods, and down the center of the canyon floor, issuing from a narrow gap in the walls, a clear-flowing stream several feet wide.

I removed my pack, sat down on the sand against the shady side of the wall, and checked my map. I'd come about five miles and had now reached Coyote Gulch, one of the major side canyons of the Escalante. The Escalante itself was still at least five or six miles away, as near as I could judge from the intricately meandering course of Coyote Gulch. I rewarded myself with a good drink of water, switched from boots to tennis shoes, and went on down the gulch, following the stream bed. This made pretty good walking most of the way—the water was shallow and the sand was firm.

Rock and water, sheer cliffs, and delicate details. On my right I saw a thread of water falling from a seep on the undercut wall of the canyon. I stepped over to the seep holding out my tin cup, and the water tinkled into it with the most musical of desert sounds. Overhead a garden grew, a hanging garden of panic grass, maidenhair fern, scarlet monkey flower, hellebore, poison ivy, and pale yellow columbine. Here would be a good place to tank up, fill a canteen or two, before beginning the walk out of the canyons. I was unwilling to drink from the creek with all those cattle upstream.

The canyon curves deeply to the left and right, sinuous as a snake, no more willing to follow a straight line than anything else in nature. On the inside of each meander the walls slope obtusely upward; on the outside, where undercut, they slope acutely, so that the curves parallel each other like a loosely jointed ball and socket. The overhanging walls resemble hollowed-out domes, some of them hundreds of feet high. Standing deep inside one of these alcoves you may not be able to see the sky at all; in such places, although damp from water seepage, there is almost no plant life, because sunlight cannot enter except by reflection. Walking in a canyon like this your points of orientation are reduced to two: upstream and downstream.

Perhaps a mile below the junction of Hurricane Wash and Coyote Gulch I rounded a bend and saw a window in the rock ahead: Jacob Hamblin Arch. Formed in the neck of a wall of sandstone that juts out into a loop of the canyon, this arch will someday become a natural bridge when the creek below completes the work of short-cutting its own meander.

The way up through the arch looked rough and rocky; with the pack on my back I preferred not to try it. Instead I followed the creek on its way around the gooseneck, passing beneath—or within—a great curved and overarching shell of sandstone. Imagine the Hollywood Bowl expanded to something like ten times its present size. The apex of this structure must be at least five hundred feet above the stream bed.

The last of the afternoon sunlight had long since vanished from the upper walls of Coyote Gulch. I walked through a lavender twilight, the murmur of flowing water, the croaking of toads. The willows swayed, the leaves of the cottonwoods rustled like paper as an evening breeze came gliding up the canyon. It was time to make camp, but the charm and magic of this (to me unknown) canyon was so great that it was hard to stop. Each turn in the walls seemed to hint of something new and even more delightful; exploring such a place is like the gradual discovery of the personality of a new friend, a new love.

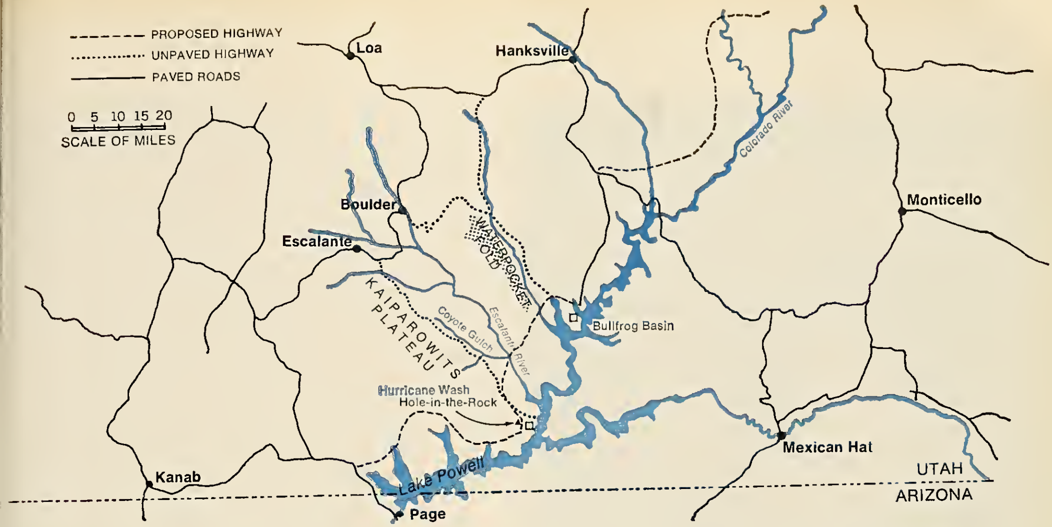
But since I would not stop for dark, the dark stopped for me, surrounded me. On a shore of sand well away from the cattle paths I made my bed—a sheet of plastic and the sleeping bag—and prepared supper in the starlight. Cottonwood makes poor fuel, burns too fast and smoky; I scrambled up the talus under the cliff, where I had earlier noticed scrub oak growing, and brought back an armload of *real* wood. Over the red coals I hydrated my dehydrated meat and vegetables, stirring up a quick goulash. Well seasoned with salt and pepper and blowsand, nothing could have tasted better.

In the morning I went on down the gulch, leaving my pack behind, carrying only enough raisins and jerky for lunch. I was now below the seepline in the overlying Navajo Sandstone formation and the stream grew larger, fed by the many seeps and springs. I climbed around a gap in the rock, which had once been a natural bridge, passed several small waterfalls, came to a natural bridge still standing. This is a young one, geologically speaking, with plenty of room for enlargement. At present it is about big enough to drive, say, a schoolbus through. Clinging to the underside of the bridge are the mud nests of cliff swallows. Against one buttress, out of the rain, I noticed the smudge of an old campfire—as if some weary hobo, accustomed all his life to sleeping under bridges, had once spent a night here. I probably know the man.

There is a sensuous pleasure in walking through such a natural tunnel in solid rock, wading the stream that made it, standing in shadow and looking back through the bridge at a portion of the upstream canyon bathed in morning light—the sparkling water, the golden slickrock walls with their tapestries of desert varnish, the bright, acid-green leaves of the cottonwoods, the rosy pink plumes of tamarisk. From the cliffs far above I could hear the sweet clear falling notes of a canyon wren—a characteristic song in this land of stone and stillness.

What would it be like to live in this place? Could a man ever grow tired of such a scene? Someday, I thought, I will make the experiment, become an ancient bald-headed troglodyte with a dirty white beard tucked in my breechclout, starving on locusts and lizards, feasting from time to time upon fresh, lost Boy Scouts. Madness: of course a man would go mad from the beauty and the loneliness, both equally incomprehensible. But perhaps it would be—who can say?—a kind of blessed insanity, like the bliss of a snake in the sun, a buzzard in the air.

The canyon grows bigger, wider, wilder as it descends rapidly, in a series of jump-offs and cataracts, toward the Escalante. At one place a vast section of the north wall has collapsed quite recently, perhaps within the past century, and has tumbled in fragments the size of boxcars into the canyon bottom. The rockfall is clean, sharp-edged, free of all plant life, even



lichens, and the floods have not yet had time to round off and polish the broken slabs that obstruct the creek. Now the footing is tricky, impossible for cattle and horses; I found steps chipped in the sandstone above the fall where some Mormon cowboy years ago had made a bypass for his horse.

More cascades, some of them fifteen to twenty feet high; at one point the only feasible route is down a log that leans against a shelf of stone on the canyon wall. Here the walls must be close to a thousand feet high on either side, and the sky is only a winding strip of blue. I walked around one more bend, hearing beyond the low steady roar of floodwater, and came to the master stream, the Escalante, swollen by the spring runoff—snow melt from the high plateaus eighty miles away.

The water was reddish brown, about ten yards wide and—as I discovered when I waded into it—knee deep in the main channel, with a strong current. There was no choice, however, but to stay in the water if I wanted to go farther; the river filled most of its canyon from wall to wall. I headed up the river: at least that way I was fairly sure I'd be able to get back to the mouth of Coyote Gulch in case the river should rise still more.

The going was hard against the current. I could feel the sand giving way beneath my tennis shoes at every step. I went only far enough up the river to see the great high window in the rock called Stevens Arch and to reach the mouth of Stevens Canyon beyond it. I had hoped to explore Stevens Canyon for part of its length, but the day was already more than half over. Reluctantly I turned back, waded the river, and walked the long winding rock-and-mud, sand-and-water way up the meanders of Coyote Gulch. Again I cooked supper in the dark—tired, hungry, happy.

On the third day, before returning up Hurricane Wash to my car, I decided to have a look at the weird world of rock and juniper that lies above and between the canyons. Upstream from the confluence of the wash and Coyote Gulch I found an egress from the canyon up a rounded knoll of sandstone. I kept climbing until I topped out on a bare ridge about halfway between Coyote Gulch and Escalante Canyon. From there I could see not only the dark gashes of the canyons below but also that hundred-mile-long monocline known as Waterpocket Fold, the snow-covered dome of Navajo Mountain, the Kaiparowits Plateau, and other mesas and plateaus east of Lake Powell and the Colorado River, some of which may have been—from where I stood—close to a hundred miles away by line of sight.

My immediate surroundings were no less interesting: a rolling terrain of largely naked sandstone shaped by ages of erosion and weathering into a surreal landscape of knobs, turrets, pinnacles, fins, potholes, and hollows. Parallel joints and seams in the rock lead to the canyon rims; cutting across these joints are a number of crevices too deep and perpendicular to descend, too wide to leap. A silent world of stone, and all of it—despite the fissured surface and the sculptured relief—united in one massive monolith of rock, ancient as the dinosaurs.

The area is not entirely lifeless. Some of the potholes contained water when I was up there, and in the water were threadworms, various kinds of larvae, and the curious freshwater crustacean, *Apus aequalis*—a holdover from the Paleozoic Era—much like a trilobite or miniaturized horseshoe crab in appearance. In the basins and depressions among the sandstone hummocks where sufficient sand has accumulated to form the basis of a soil, I found junipers and other plants, many in bloom: yucca, cliff rose (fragrant as orange blossoms), prickly-pear cactus, Indian paintbrush, princess plume, purple penstemon, globe mallow, sand verbena, and evening primrose.

I'd neglected to mark my trail and so spent a couple of hours searching for the way back down into Coyote Gulch. All of the sandstone hills look dismayingly alike when you're lost and my first two approaches to the canyon ended at rimrock. Each time I had to backtrack, circle, and try again; at last I

found the one and only route down. Strange and beautiful though it is up in the slickrock wilderness, I had no wish to spend the night there without food and sleeping bag. Down in the canyon I returned to my pack, had something to eat, filled my belly with water, and began the twilight walk up Hurricane Wash toward my car and the road that leads back, not necessarily to home, but to where we all are now.

A Footnote to the Walk

It will come as no surprise to readers of this magazine to learn that a place as serene, lovely, wild, and magnificent as the Escalante wilderness is not to be left undisturbed. Anything good can always be improved upon by a vigorous application of dynamite, bulldozers, draglines, dump trucks, and earthmovers, finished off with a thick, smooth coating of asphalt. Or so believes the corporate brain of any normal state highway department and its supporting combine of auto dealers, road contractors, construction unions, filling station operators, motel managers, and small-town Chambers of Commerce—all the homogeneous Babbittry of America who have not lessened one degree in avarice, myopia, or enthusiasm since Sinclair Lewis wrote his futile book more than forty years ago; who have, if anything, become even more vulgar, even more aggressive and destructive, in the present. Profit is their aim and pollution is their grossest national product. Pollution in every sense—and of every sense.

The Utah State Department of Highways conforms to the pattern devoutly. Where I walked out of the gateway of Coyote Gulch and into the deep golden canyon of the Escalante, under the blue window in the cliff called Stevens Arch, the state engineers propose to blast roadways through the canyon walls and join them with a huge bridge. The bridge will serve to complete a projected highway that will begin in Grand Junction, Colorado, cut across the southeastern corner of Utah, and terminate near Page, Arizona. (Proponents of the road estimate its total cost at $24 million; those who oppose it, at $90 million.) The 37-mile stretch of highway that would cross the Escalante area begins at Bullfrog Basin, northeast of the Canyon, and ends southwest of the Canyon at a place known as Hole-in-the-Rock. If constructed, this portion of the highway would lead, in effect, from nowhere to nowhere.

Hole-in-the-Rock is the possible site of a possible marina. Not a good site, because it is too small in area and some thousand feet below the end of the access road. (The gap varies with the fluctuation of the water level in the reservoir.) Although of modest historical interest, there is no development of any kind at Hole-in-the-Rock now. Nobody lives there and nobody has ever lived there; it is sixty miles by primitive dirt road from the nearest town (Escalante).

The other end of the proposed Escalante stretch of the highway (to be paid for, of course, out of federal, not state or local, funds) would lie in the place called Bullfrog Basin, a small and remote marina that is destined to be silted in and useless, some say in fifteen years, some say in thirty. Bullfrog Basin is accessible by paved road via Hanksville, from the north.

The estimated cost of the 37-mile highway from Bullfrog Basin to Hole-in-the-Rock is $6 to $7 million (although the road's opponents claim a cost of about twice this sum). The high cost of such a short auto artery follows from the sad fact that the planned route, which is the only possible route, goes against the grain of the landscape and at right angles, or crosswise, to the natural lines of travel in the area. To get from Bullfrog Basin (population about twenty souls?) to Hole-in-the-Rock (uninhabited, nothing there) the builders will not only have to blast through the walls of the Escalante and bridge the river, they will also have to lay part of the roadway on talus slopes of sand and tunnel or notch or cantilever a major section of the road through, or somehow over, the complex canyons and escarpments of the Waterpocket Fold. The road can be built; our engineers can do anything if we permit them. But this particular road would be extravagantly expensive, unavoidably destructive to the landscape, and conspicuously useless.

Perhaps the last objection is not important. Art is useless; this article is useless; moon trips are probably useless. Technicians have as much right to do their peculiar thing as anyone else, since it pleases them, however silly it may appear to others. Uselessness, then, is of little importance. The essential objections are the expense and the destruction.

The small businessmen of the Escalante area (and nce the area is largely wilderness they are not any) think that any kind of public construction will enefit them in some way, so long as the cost is borne y the rest of us. But there are a few things that even antily populated southern Utah needs more than owhere roads—such things, for example, as new hools, medical services, better housing, agricultural ids, and pollution control. Since the money for the roposed highway is to come from the Economic evelopment Agency, it would seem appropriate to pend it on actual human needs rather than on one ore facility for motorized tourism.

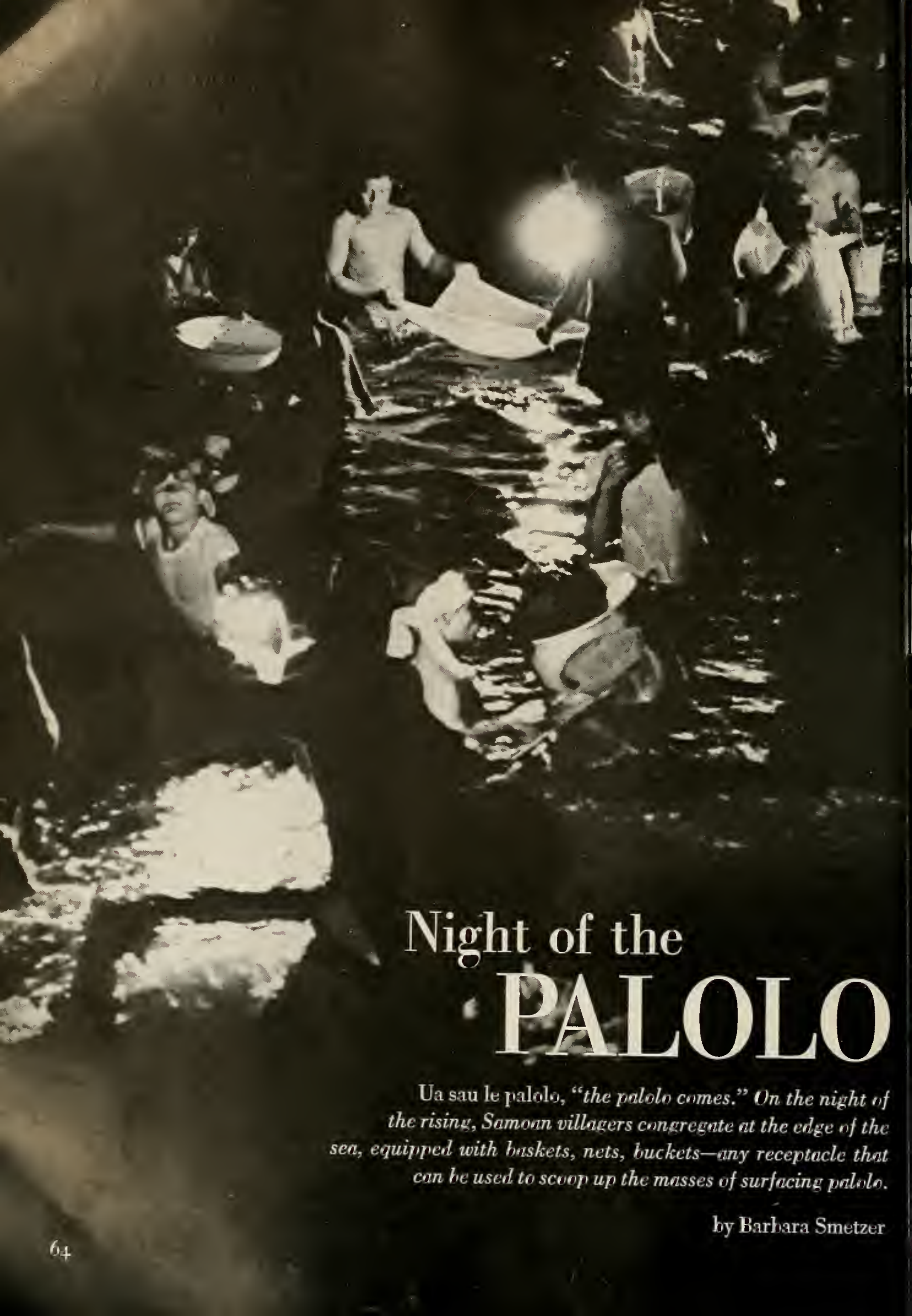
Misappropriation of public funds is bad enough, but e destruction of the landscape and the further isection of the last remnant of the Glen Canyon ilderness—of which the Escalante River and its anyons is a part—is worst of all. Most of the people f southern Utah do not yet realize it but their most recious natural resource is not carnotite or potash or and-tar oil, it is the grand, spacious, free, and un-bright land itself—the whole primitive wonderland f canyon and mesa and desert. The living heart was len Canyon and the river, and someday they will oth be restored to us. (I am not one of those who believe that the Powell reservoir is here to stay; I predict that Glen Canyon Dam, already obsolete as an efficient power-producing system, will be dismantled and removed by the more enlightened generations that are now coming up from the universities.) In the meantime we must treasure what little free space and open air still remains, save it from the road builders and the other varieties of commercial exploitation. The Escalante wilderness is the best we now have left of what was once something better, and it is federal land, public land, the property of all Americans. Its magic and beauty can never be reached by automobile because wilderness is the essence of it; but the canyons are open and available to all who are willing to make a little physical effort and who retain in their hearts some residue of that love for adventure that is, supposedly, a basic trait of our national character.

A Footnote to the Footnote

Detailed information concerning the trans-Escalante highway controversy can be obtained from:

(1) Information Office, State Highway Department, State Office Building, Salt Lake City, Utah 84114 and

(2) The Escalante Wilderness Committee, P.O. Box 8032, Salt Lake City, Utah 84108



Night of the PALOLO

Ua sau le palolo, "the palolo comes." On the night of the rising, Samoan villagers congregate at the edge of the sea, equipped with baskets, nets, buckets—any receptacle that can be used to scoop up the masses of surfacing palolo.

by Barbara Smetzer

It is midnight on the eighth day after the full moon in November. The quarter-moon has not yet risen, and the sky is dark. Here and there a lantern moves across the waters of the reef as a figure bends low and peers into the water. On the beach, clusters of people sit cross-legged on the sand, their lavalavas tucked under their knees. For a moment they watch for a sign from the men on the reef. But the reef watchers are silent. Then someone on the beach starts to sing, and with a whoop, an old woman leaps to her feet. The people laugh. Up jumps an old man. He gleefully approaches the old lady. The people clap and start to sing. Knees bent, arms outstretched, fixed smiles on their faces, the old people start to dance, their figures silhouetted in the firelight against the cluster of thatch-roofed *fales* that line the beach.

In the village, boys and girls hurry about, gathering buckets, pails, nets, and flashlights. Several women sit in front of their *fales* stringing blossoms into an *ula*, "necklace." A gust of wind brings in a strong smell from the sea to mingle with the fragrance of the moso'oi flowers. Waves slosh against the shoreline, and high above, the leaves of coconut trees rustle in the tropical night air.

Suddenly one of the reef watchers moves about quickly, scoops his hands into the water, and cries *Ua sau le palolo*, "the palolo comes." Immediately the dancers and merrymakers leap to their feet, grab their buckets, nets, and pails, and wade into the water, shouting, laughing, and playfully pushing each other for a good position. The light from their lanterns spreads in fractured beams across the dark, choppy water and reveals thousands of wriggling, wormlike creatures known zoologically as *Eunice viridis*. The water is literally alive with the swarming masses of palolo, and for the next hour or two the people of the Samoa Islands work feverishly to scoop as many of the squirming creatures into their baskets and buckets as they possibly can before the palolo "melts," or disintegrates. For the palolo comes to the water's surface only twice a year and the people must wait until the following October and November to harvest it again.

The palolo has long been a source of gustatory pleasure to Samoans and an object of curiosity to scientists. Through the years many scientists have studied this annelid in Samoa and have recorded zoological information about it. But there is another body of information that also needs to be recorded: the folklore surrounding the palolo. The rising is a much anticipated event, and there are legends to explain the palolo's origin, signs in nature that foretell its coming, and customs involving the catching and eating of this squirming delicacy.

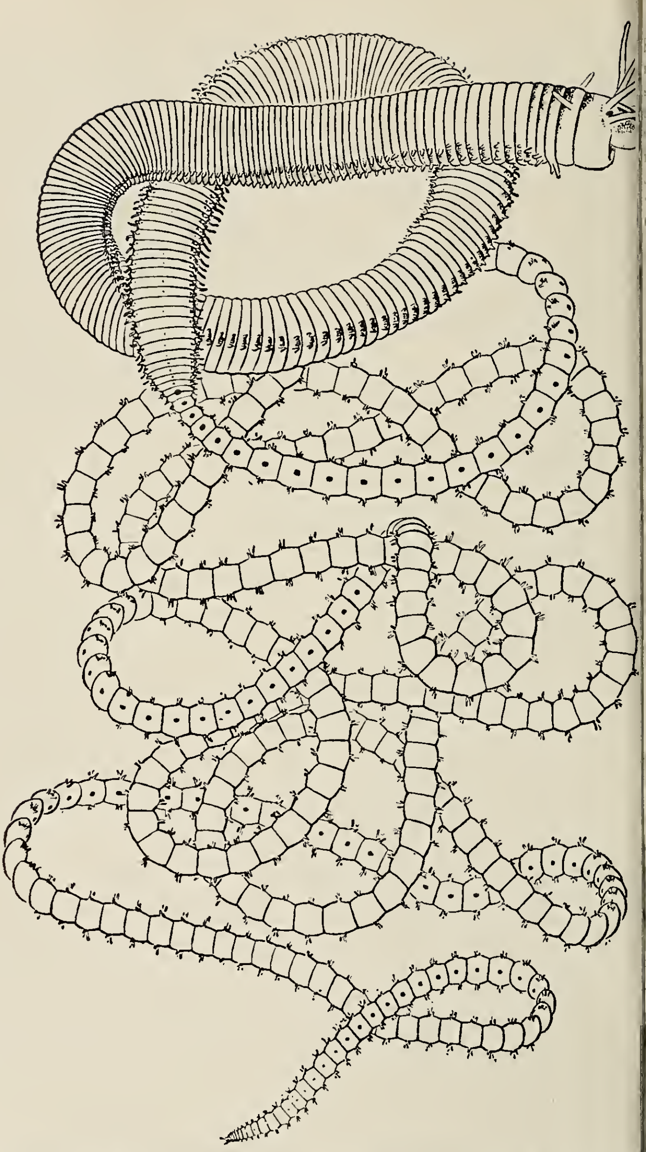
The palolo first came to the notice of Europeans through the writings of missionaries who were intrigued by its dramatic and punctual rising. Rev. John Stair, writing in 1840 of his life on the islands in *Old Samoa, or Flotsam and Jetsam from the Pacific Ocean*, noted:

"One other curious example of Samoan natural history remains to be noticed in a remarkable sea-worm, Palolo, of the natives. It is most singular in its habits and history, and is much prized by the natives as an article of food. This remarkable worm . . . rises from the reefs at certain places of the islands in the early part of the two days only —in the months of October and November in each year, and is never seen at any other time. . . . After sporting on the surface of the sea for a few hours on each day, they disappear as mysteriously as they came, and none are ever seen until they return of the next season, when they repeat their visit under the same mysterious conditions."

In 1847 Rev. Stair sent a specimen to the British Museum for classification. In 1898 whole specimens were obtained from the reef, and the palolo was classified as *Eunice viridis*. As more researchers came to Samoa, removed pieces of the reef from the bays, and studied *Eunice* in its natural habitat, much of the mystery of its behavior was dispelled.

Eunice viridis is an edible annelid that lives in the coral reef in long, twisted tunnels made by another sea worm. Twice a year, in October and November, on the sixth to eighth day after the full moon, the posterior portion of *Eunice* breaks off from the anterior part and rises to the surface of the water in large, funnel-shaped swarms. In a matter of minutes the water is filled with masses of palolo, which different observers have described as wriggling worms, fine straws, small snakes, or vermicelli. They wriggle about in the water for one to two hours; then their saclike bodies burst open and cover the water with an oily scum. The body wall soon disintegrates, releasing sperm and eggs into the water, and in three days a new creature is formed, which sinks down to the reef to begin life anew. A token rising may occur in October and a large one in November, or vice versa.

The total length of *Eunice viridis* is about 400 mm. (16 inches) and the length of the free-swimming part is an average of about 300 mm. The posterior portion of the body resembles a segmented cylinder with each segment bearing a pair of bristles and a ventral eye. The male is reddish brown or yellow; the female, deep bluish green. The deep green color of the ova in the female's posterior region gives the specific name *viridis*.

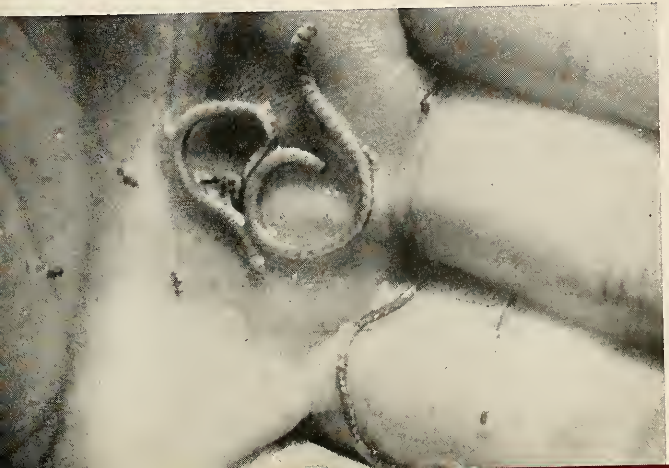


Many factors—light, heat, salinity, water pressure, and atmospheric electricity—have been mentioned to explain the periodic swarming of the palolo. W. McM. Woodworth (Harvard Museum of Comparative Zoology), who studied the spawning process in 1898, suggests that there might be a reaction to heat and light in the ventral eyespots. On the posterior segments, these circular, pigmented spots are deep brown or black. They are also found in the anterior region through about twenty segments, but here they are small in size and pale in color. The presence of the eyespots and the swarming of the palolo during the season of neap tides, when the sun is nearest its zenith and when its light and heat are greatest, suggest that *Eunice viridis* reacts to light and heat.

A recent investigation of the periodic reproduction of *Eunice viridis* was made in 1966 by Hauenschild, Fischer, and Hofmann, three German scientists who isolated complete specimens from the reef prior to the annual swarming. They concluded that the sexual maturity of the palolo is brought about by a hormone in the anterior part. They also discovered, when they dug into the coral reef, that the worms were in various stages of development, some with immature germ cells or none at all. Thus they concluded that sexual development for all the specimens is not synchronized all year-round and that there are external factors that act on certain specimens to promote sexual maturity and as stimuli for simultaneous breeding.

From a 1955 survey, biologist William Burrows concluded that *Eunice viridis* and similar marine annelids are found in Fiji, Western Samoa, American Samoa, Tonga, and Rarotonga (Cook Group); also in New Hebrides, and in a number of places in the Solomon Islands. A similar creature has been reported from New Guinea, the Trobriands, New Ireland, New Mecklenburg, and Thursday Island in the Torres Strait, but Burrows had no evidence that these were *Eunice viridis*. The Atlantic palolo of Tortuga has been studied for many years, and there is a Japanese palolo called *bachi*, which swarms after the new and full moons of October and November.

The palolo is a segmented annelid whose wormlike body may reach a length of about 16 inches. In October and November, the body's posterior portion floats to the ocean surface where reproduction takes place; the anterior remains beneath the surface, fastened to coral reefs.



The palolo, then, is not peculiar to the Samoa Islands, but many observers and writers have noted the high regard in which it is held by Samoans. One writer even described the Samoans as being "crazy for the palolo." It is only natural that a creature that appears in such a dramatic way and that is eaten with such relish would attract legends to explain its origin and habits.

Ventral eyespots, tufted gills, sexual maturity—these do not concern the Samoan; the islander's interest in the palolo has little to do with its zoological characteristics. Through hundreds of years of catching and eating the palolo, the Samoan has had to deal with other kinds of questions: Where did the palolo come from? On just which day will the palolo come? How can you tell if there will be many or few? What can you do to make the palolo rise in large numbers? What can you use to scoop thousands of tiny, wriggling worms out of a choppy surf? How do you eat or cook a bundle of wriggling worms? In a tropical climate can you preserve some palolo for later use?

In the "old days" legends describing the palolo's origin were known by the village chiefs and "talking chiefs," and narrative explanations differed among the islands' villages and districts. Many of these stories have been forgotten today, but a few are remembered and some have been recorded in print. The following legend was told by an old woman in the Atua district of Upolu Island, Western Samoa, and was recorded by the German scientist Benedict Friedlaender in 1898.

"There were three brethren, two men and one woman. The men's names, Avali'i and Avasa, the girl's, Toofana. Those came swimming from Viti. As they came to one of the boat passages in Samoa, the girl wept. Her brothers asked her what the matter was. She replied that she wanted to attend to a call of nature. And the brother told her: 'Do it in the boat passage, that there may grow from it palolo.' Thereupon the boat passages kept their names up to today—Avali'i at Matatufu, Avasa at Lotofaga, and Toofana at Aleipata."

In the mythology of Samoa, the Manua group of islands holds a special place. The following story about the palolo was told by the late Talking Chief Siva of Tau village, Tau Island, Manua.

"Everything that is good starts first in Manua. The sun rises in Manua. The palolo rises first in Manua.

"A long time ago there was a man named Lalafatau. He lived in Manua Islands. His own home was a big rock. He was always fishing, every day. One day he got an eel from the river.... He thought, 'What shall I do with that eel?' He thought, 'I must cut that eel in two parts,' and he cut that eel. The first part is the head and the second part is the tail. Lalafatau brought the eel out into the sea and the tail sank down to the bottom of the sea. In the sea the tail sank beside the big stone. The name of that stone is Puga. The Puga ate the tail of the eel. Lalafatau looked into the sea. There is no tail, only the Puga.

"Lalafatau threw the tail in the sea in the month of September. He watched that stone in the weeks from September to October. He went to the sea with his boat and he looked and looked way down. He saw that big stone and the big stone had borne out the things like worms.

Lalafatau put his hands down in the sea and he picked those things up. They melted on the first night. The second night the Puga borne again. He picked them up again; the things were hard. So he returned to his home and he named those things palolo."

In another story concerning the discovery of the palolo the central character is a man named Puga. This story is the one that is known in Aua village in the bay area of Tutuila Island and was told by Chief Sonoma Unutoa.

"Once upon a time there was a chief named Puga and his two sons. They lived in Mount Pioa which now they call Rainmaker. About the early part of October. Chief Puga went out fishing at midnight. The moon was about coming up. He saw tiny, long worms swimming around his canoe. He tried to pick them up. but they were very soft. About daybreak he went home and told his wife and sons of what he has seen while fishing.

"He instructed his two sons, 'Tonight we all go fishing, but before we go, we should have some baskets and brooms.' They went out about the same time the chief went the previous night. They got plenty of palolo. This happened about seven days after the moon's last-quarter.

"They tried again in November and they got more than October. They tried the same in December but they didn't get any. Again in January, nothing. From that they think palolo only comes up during October and November."

There is also a cycle of stories telling of a fight between the corals of the sea. the fish of the sea, and the creatures of the land. Several of these stories were recorded in 1962 by Tofa I'iga Pisa, a well-known Western Samoan. who was renowned for his knowledge of Samoan custom and tradition. In one version of the "fight" story told by Tofa I'iga Pisa. the ocean corals captured worms from the land and placed them down in the reefs as prisoners of war to serve the coral leaders. They were imprisoned for life, but twice a year they were allowed to rise to the surface. In another version of the war story, told by Chief Sua of the village of Ili-ili on Tutuila Island, the birds and fish of the area had a fight, but the palolo did not participate because of its wormlike nature. It just hid in the corals. After the war was over the victorious fish decided that the palolo should rise to the surface of the water twice a year so that people could use them for food.

While most villagers wait on land, reef watchers wade off shore, scanning the ocean's dark surface for the first signs of the palolo.

These are typical examples of stories that the Samoans tell to explain the origin and discovery of the palolo worm, but of even greater significance to Samoans is the question, "on just which night will the palolo rise?" Everyone knows that the great rise will be on the sixth to eighth day after the full moon in October or November. But pinning it down to the exact night and the exact hour is the real fun. People talk and speculate about this several weeks in advance of the day, and there are certain individuals who are believed to have special knowledge in this matter. One person well known for his accurate predictions about the palolo's rising is a German Marist, Brother Herman, a resident of the islands since 1913. Many Samoans go to Brother Herman to hear his prediction. for they believe that he is always right. (For 1969 he has predicted that the palolo will rise on the night of November 2. eight days after the full moon of October 25.)

How did islanders know when the palolo would come in the days before they had access to the calendar? Here is one chief's description:

"If you want to know when the palolo is coming, the first thing you have to do is watch for the signs in nature. Because the people in the old days did not have any calendar and they had to look around at the trees and the shrubs and the moon and things like that to tell what is the time of the year. The season of the year when the palolo comes, that is called *vaipalolo.* It is something like the spring of the year when certain flowers and trees come into bloom and the reef is full of many kinds of fish. So, when you look out into the forest or the bush and you see some of these flowers blooming . . . then you know the palolo is coming soon.

"About one to two days before the night for palolo there are some other igns that you notice. The first is the ign of smelling. Maybe you are sit-ing in your home and you smell a trong fragrance from the sea. That s called the *manogi o le pua o le alolo*, 'the smelling of the pua of he palolo.' The people believe that hat is something like the breath or the blowing out of the palolo. You an just sit in your house and when a strong wind blows, then the smell of the palolo will be very strong. Then if you walk down to the sea you will see another sign. All over the water you will see something that looks like brownish bubbles or foam. It is just like the foam that you make from soap. And it floats on top of the water just like foam. The waves wash it ashore and it lines the beach, and in the calm places of the water—like the channels—it just floats on the water. That is called the pua of the palolo, so when you get that strong smell from the sea it is called the smelling of the pua of the palolo.

"Now there is another thing that happens and that is the *palulu* flower. The *palulu* is the blossom of a vine and that flower blooms every morning. But one to two days before the palolo night, that flower does not bloom. The blossom just closes up. And then, after the palolo is over, then that flower blooms again. So, when the people smell that fragrance from the sea, and when they see the scum or the foam on the water and they look and see that the *palulu* flower is closed, then they say the time for palolo is very near, maybe that night or the next night.

"Also, there is a certain kind of breadfruit tree growing high on the mountain that bears a crop of fruit at this time. When the branches of this tree bend to the ground, then you know it is time for palolo.

"The day on which the palolo rises is usually a stormy one with lightning and thunder, rain and wind. A storm blowing landward will help to push the palolo nearer to the shore, but a strong wind blowing to the sea may push them out to the ocean. Then the people say, *Ua tafea palolo*, 'the palolo is washed away.' "

The quantity of the palolo's rise is also an important matter to the islanders, and they watch for certain signs that will tell whether there will be many or few palolo. If the flowering trees and shrubs put forth many blossoms, if the smell from the reef is very strong, and if there is lightning, thunder and rain, there will be many palolo. But if the day is clear and still, if the smell is not strong, and if the blossoms are scanty, then there will be only a few palolo.

There are several things that the people can do to increase the palolo rise. As one person described it:

"The people believe that the palolo will come greatly if they get ready for its coming. All the women of the village come together and make *ulas* from the moso'oi flowers. And the belief is that the more *ulas* they make, the more palolo will come. They say the palolo sends the smell to the people and the people must send the smell back to them. You know the moso'oi flower smells very sweet. Also, the people must get ready and make their preparations. They must cut the banana and breadfruit leaves, weave the coconut baskets and line them with *lau'a'a*, and get the nets and lanterns ready. And the people say, if you do all these things then you will have many palolo."

Six to eight days after the full moon of October and November the palolo start to rise. There is a widespread belief that if the full moon is in the early part of October, that is, before the fifteenth, there will be few or no palolo that month. The large rising then will come in November. If the full moon is in the latter part of October, then there will be many palolo. Many Samoans say that in all their years of watching for the palolo, they have never known this to be untrue.

The "palolo time" in Samoa lasts for three successive days. Woodworth recorded this in his 1903 article and he lists the names of the three days as *salefu*, *motusaga*, and *tatelega*. According to Woodworth's list, *salefu* is the first stage of the palolo when a few of the worms are scattered on the water as a sign that the palolo is coming on. On *motusaga* night they appear again, but they are not mature, are easily broken, and melt quickly. *Tatelega* is the great night for the palolo, when the worm appears in large numbers and remains firm even when touched.

The time of night when the palolo appears varies on the different islands. In the easternmost Manua Islands, the palolo appears between 12:30 and 3:00 A.M.; on Tutuila Island, between 2:00 and 4:00; on Upolu (in Western Samoa) between 4:30 and 6:00; and in Savaii, the island farthest west, after 6:00 in the morning. Some people in American Samoa believe that the moon affects the palolo—that it will melt when the moon's rays shine on it. In Western Samoa they believe that the sun causes melting.

On each island, about two to three hours before the palolo is due to rise the people start to gather on the beach and in the villages. Several watchers go out onto the reef to wait for the rising to begin. The scene is one of great merriment; everyone is excited and gay. Some people sing and dance, while others gather the baskets, nets, and lanterns, make the *ulas*, and get the boats ready. The palolo is caught both in the shallow water near the beach and in *paopao* boats at the edge of the reef.

The methods and equipment for catching the palolo have been refined over many years of practice, and Samoan ingenuity was fully used in the construction of palolo-catching devices. Like so many other objects of Samoan material culture, the coconut tree yielded almost all the material for this equipment. Dried coconut leaves were used to make torches; a *molielo* light was made by pouring coconut oil into a coconut shell and lighting a wick of mulberry cloth; and brooms were fashioned from bunches of dried coconut-leaf midribs tied together with sennit—a string plaited from the dry fibers of the ripe coconut husk. The broom was swept across the water, pushing the palolo into a basket. At the base of the coconut tree grows a fibrous substance resembling rough natural cheesecloth. Called *lau'a'a* by the Samoans, it is tied onto a moon-shaped stick and used as a bag for scooping up the worms. The worms are then placed into a basket made from the green leaves of the coconut tree and lined with *lau'a'a*, which acts as a sieve to drain off the salt water and hold the small worms in the basket. If the salt water is not drained off quickly, the palolo will burst and melt.

Of all these objects, only the Samoan broom and the green leaf basket lined with *lau'a'a* are still in use today. Scoops are now made from cheesecloth or netting; gas lanterns and flashlights have replaced the torches and *molielo* light; and many kinds of baskets, buckets, and other containers are used.

Once the palolo is caught it is eaten raw or wrapped in leaves and broiled on hot charcoals made from dried coconut shells. It can be wrapped in breadfruit, pata, alofao, or lagapapa leaves and baked in the *umu* ("earth oven"). When cooked, the palolo turns a deep green color much like spinach, and the taste is strong, salty, and of the sea. (A sample of palolo was analyzed at the Hawaii Agricultural Experiment Station and was found to be very nutritious—a good source of protein, calcium, phosphorus, vitamin A, and riboflavin.)

In parts of the islands where there are inland villages, special runners are dispatched to carry palolo bundles to relatives or friends unable to catch their own. Most palolo is eaten fresh, but certain portions of a family's catch are set aside for special purposes. Bundles weighing from six to ten pounds are wrapped in leaves and baked in the *umu* until the water is gone and the palolo looks dry. One bundle is reserved for the chief of the family, but if there is any palolo left over, the other households in the extended family may also have a bundle.

Bundles are put in special baskets and hung from the rafters of the house. Every day or two the men of the village who attend the family chief take down his bundle, add coconut cream to it, and recook it in the *umu*. This is done for as long as the palolo lasts, sometimes up to a year. These bundles of recooked palolo are called *ofu fafaga*, meaning "feed the bundle every day," which refers to the addition of the coconut cream. Palolo from the family bundle can be eaten at any time, but palolo from the chief's bundle can be used only for ceremonial occasions. At such times it is given to the chiefs and elders of the village, who are held in great respect.

The custom of preserving the palolo and serving it on ceremonial occasions was reflected in the names of two months in the Samoan calendar. In Old Samoa the name for July was *Palolomua*, which meant "first promise of palolo." August was *Palolomu'i*, "last before the palolo." During these two months, according to Tofa l'iga Pisa, the last of the preserved palolo was served in anticipation of the next rising. September was *Mulifa*, "end of the season," and boat making and other activities were begun in preparation for the arrival of the new palolo season in October-November.

The palolo also lent its name to the seasons of the year, for the word *palolo* refers to something more than just a sea worm. It refers to the general awakening of the earth in the spring season and the ceremonies, feasts, and fishing parties enjoyed during this time. In the following passage Chief Unutoa described that time of the year in Old Samoa:

"In the old days there were two seasons of the year. The time from October to March was the *matagi o le vaipalolo*, or the *vaipalolo* season. Sometimes it is called the rainy season or the stormy season or the hurricane season, because that is the time of the year when we have the big storms.

"But the other season is the *vaitoelau* and that is when the *toelau* wind blows. That is a wind that the people believe comes from the Tokelau Islands and that is a very good time for planting. The old people say that it is the time to plant your taro and bananas when the *toelau* wind is blowing. Some people call that the trade winds. Well, this season that is called the *vaipalolo* was a very important time in Samoa, especially the time when the palolo rises. The people always enjoyed the coming of the palolo and they looked forward to it for many days before it arrived. Then, about two days after the palolo came, there was a special fishing party or contest that the chiefs had called *alafaga*. You see, they believed that many fish would come close to the land at the time of palolo because the fish liked to eat the palolo also. So, about two days after the palolo, the chiefs and the talking chiefs would gather at the home of one chief. And they would take their fishhook, the one called *pa*, and their lines, and early in the morning they would get in their boats and go out into the sea. They divided up into something like teams and they tried to see who would catch the most fish.

"So, the chiefs fished and then when they returned they all gathered round to see what they had caught. And the team that had earned the most points [each fish had a different point value], that was the winner. The losing team then had to make a feast for the winners. And the people on the winning side would say, 'Bring some taro, bring some breadfruit, bring a roasted pig,' and told them to bring all the things they wanted to have for the feast. Now there was a special food that was prepared for this feast and that was called the *samilolo*.

"About a week before the time for the *alafaga* the young men of the village gathered the green coconuts. They took out the juice and filled up the shells with salt water. Every day they put in fresh salt water. And in about a week's time the coconut meat was very, very soft. It looked something like what you call mayonnaise. So, they scooped out this coconut meat and wrapped it in a banana leaf and baked it in the *umu*. Then they served this food at the *fiafia* ['feast'] after the *alafaga*. It was very good and tasted something like cheese. And they had this *alafaga* fishing party and the feast with the *samilolo* just two times a year. Once after the palolo rising in October and once after the palolo rising in November.

"In the old days they had this in many villages but today they only do this in a few villages."

This type of fishing with a hook, called *pa*, and the special ceremonial food, *samilolo*, have been used as an explanation for the derivation of the word *palolo*. An explanation that is widely accepted and often quoted is that *pa* means "to burst open" and *lolo* means "oily," or "fatty." The word, according to this explanation, refers to the bursting of the palolo when the eggs and sperm are expelled into the water and turn into

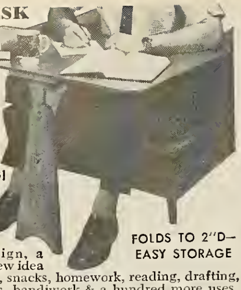
n oily mass. This is the explanation
at was given to August Kraemer,
e German scholar whose book *Die*
amoa Inseln is the classic work on
ineteenth-century Samoan life, and
he one that most writers have re-
eated since that time. But this ex-
lanation was challenged in 1962 in
n article by Tofa I'iga Pisa, who
tated that *pa* refers to the fishhook
nd *lolo* refers to the food *samilolo.*
e maintains that the palolo fishing
nd the *alafaga* fishing were all part
f a special time during the *vaipalolo*
eason and that the word derives
rom that time. It signifies, he says,
ot only the annelid, but the bloom-
ng of spring, which in the Samoan
alendar marked the beginning of a
ew year—a time of abundant rain-
all, excellent fishing, scented blos-
oms, and the reawakening of the
arth and water.

This closeness to the rhythms of
ature, which the Samoan had in the
ld days, has been broken by the in-
rusion of modern life. In American
Samoa where the most rapid changes
n the traditional life are taking
place, the palolo is still very much
appreciated, but some of the customs
are no longer observed. As one man
explained: "Today you just pull up to the beach in your automobile and jump out with your Coleman lantern and tin bucket. If you get extra palolo you put it in the freezer and eat it all year round. If you get many palolo, instead of sending some to your *matai* ['chief'] or your friends, you take it to the market and sell it for money."

Variously described by Western observers as "small snakes," "vermicelli," and "wriggling worms," palolo are a Samoan delicacy, whether baked, broiled, or eaten raw.

Recently a bill was introduced into the legislature in Pago Pago that would make Palolo Week an official event. The tourist bureau describes palolo catching in its brochure and invites the tourist to come and try it for himself.

But none of these changes has altered the Samoan's great pleasure in catching and eating the palolo. For on the sixth to eighth day after the full moon of October and November, when the *palulu* flower closes its blossoms, when the strong smell comes from the sea, and a brown foam covers the water, the Samoan Islanders will once again gather on the beach to await the cry of the reef watchers, *Ua sau le palolo,* "the palolo comes."



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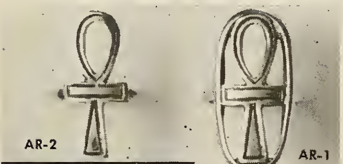

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Books in Review

Reflections of an Astronomer

by Peter van de Kamp

THROUGH RUGGED WAYS TO THE STARS, by Harlow Shapley. *Charles Scribner's Sons, $6.95; 180 pp., illus.*

These vivid and personal reminiscences by Harlow Shapley make excellent reading, covering, as they do, half a century of science and other aspects of life, recorded by a curious and courageous mind.

At the age of 15, Shapley was attending school in Pittsburg, Kansas. At 16, he became a crime reporter on the *Daily Sun Chronicle* and worked for the Kansas newspaper for two years. His sister wanted the Shapley boys to go to college but Harlow and his older brother, John, were refused admission to the Carthage High School—neither was qualified. They went instead to the Carthage Collegiate Institute from which Harlow graduated in 1907 after two semesters of residence. He managed to get admitted to the University of Missouri, intending to study journalism, but that school had not yet opened. In the catalog of courses, the first offering was archeology, which Shapley could not pronounce. Turning the page, he saw astronomy. That was it. Shapley had found his field. His studies with Prof. Frederick Seares determined Shapley's career in astronomy, and he never went back to journalism. During his four years at Missouri, Shapley earned his bachelor's and master's degrees. In the fall of 1911 he received a Princeton Fellowship and started working with Henry Norris Russell. These reminiscences are dedicated to Russell, whom Shapley greatly admired.

Shapley's primary activity was the study of eclipsing binaries. In particular, he had a number of ideas about determining their distances, using colors and spectra. In 1912, Shapley's first papers on this subject were published. Two years later, he accepted an offer to go to Mount Wilson, where he was assigned to help Seares, now an astronomer at Mount Wilson, on the colors and magnitudes of stars. During a visit to Harvard, Shapley had met the famous Annie J. Cannon, director E.C. Pickering, and astronomer Solon I. Bailey. The latter, having heard that Shapley was going to Mount Wilson, suggested that he use the 60-inch telescope, the largest at that time, to study stars in globular clusters. The consequences of this suggestion proved far-reaching.

At Mount Wilson Shapley started his work on globular clusters and Cepheid variables. Within a year, he published a paper on *The Nature and Cause of Cepheid Radiation;* this was the pulsation hypothesis, which is still being used.

Shapley found Cepheids in globular clusters in addition to those discovered by Bailey. He now made use of the period-luminosity relation of Cepheids discovered in 1912 by Henrietta S. Leavitt, of the Harvard Observatory, and of earlier work by Ejnar Hertzsprung on their distances. The distances of several globular clusters could now be determined, and they proved to be tremendous.

Shapley's distances of globular clusters and their arrangement in space were published in 1917 and 1918. His revolutionary conclusion was that the solar system is far off from the center of the galactic system. Among those who were skeptical of Shapley's work was Heber D. Curtis of Lick Observatory, who was also skeptical of astronomer van Maanen's work on the observed rotation of galaxies. At the suggestion of George Ellery Hale, Curtis and Shapley met in Washington at the National Academy of Sciences on April 26, 1920. Curtis maintained that the spiral galaxies were external to our Milky Way system. Because of van Maanen's spurious results, Shapley argued erroneously that the spiral galaxies were very near.

As a by-product of this trip to Washington, Shapley was "looked over" for the possible directorship of the Har-

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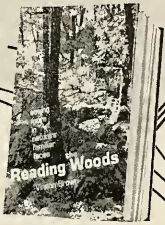

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vard Observatory. Shapley went to the Harvard Observatory in April, 1921, with the title of observer. A few months later the title was changed to director. The Harvard Observatory was somewhat run down; its principal staff consisted of Annie J. Cannon, E. S. King, and Solon I. Bailey. Here was a chance to build up a staff along the lines of the one at Mount Wilson. Shapley found that he was a capable administrator who was able to bring the observatory and the university closer.

Shapley describes how he became involved with the Magellanic Clouds, a pair of irregular galaxies less than 200.000 light-years away, and other investigations dealing with the Southern Hemisphere. He tells of Einstein's visit to Harvard in 1935; the weekly "Hollow Square" sessions at the observatory; his activities in Science Service, the Science Talent Awards, and Sigma Xi; and the founding of the magazine *Daedalus*, the quarterly of the American Academy of Arts and Sciences.

He recalls his involvement with the National Science Foundation and the birth of UNESCO. He quotes the beginning of UNESCO's charter: "Since wars begin in the minds of men it is in the minds of men that the defenses of peace must be constructed." He describes his fights with the Un-American Committee and his meeting with Henry Wallace, whom he considered a scientist or teacher, rather than a statesman.

My personal interest in Shapley's work, and its subsequent influence, is the result of having begun my astronomical studies in 1918, just after Shapley's great work, and of having witnessed the exciting developments in the "golden days" that followed. The "golden decade" (1917-27) saw the falling into place of many pieces of what had, up to 1917, been a puzzle. I remember vividly the first time I met Shapley and heard him lecture at a meeting of the Netherlands Astronomical Club in Leiden, May 27, 1922. In particular, I recall the questions from Pannekoek, Easton, and others, and above all, Shapley's opening remarks: "There is no country where the percentage of students of the structure of the Universe is so great. I am sorry that the greatest of all, Kapteyn, is so ill that he cannot be present."

It is well to reiterate and stress Shapley's revolutionary astronomical work, which made him world famous while he was still in his early thirties. In 1918 Shapley placed the solar system some 30,000 light-years off the center of the Milky Way system of stars. This galactocentric viewpoint, successor to the heliocentric viewpoint, is now basic in all stellar research. It

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presented a step forward in astronomical thinking and planning, comparable to the introduction of the heliocentric viewpoint of Copernicus in 1543. The galactocentric viewpoint now completely accepted and so taken for granted that it may be difficult for younger astronomers to comprehend that it involved the overcoming of established systems and prejudices, and that this giant step forward was due not only to a substantial amount of observational work, but also to the insight, intuition, and courage of one individual.

It is perhaps fitting to mention here some outstanding personal characteristics of Harlow Shapley. He is a man who makes us aware of the problems of nature and man, not through suggestion or force, but through his wit, marvellous sense of humor, patience, and the power of his personality. He is a man of faith and curiosity, who never ceases to enjoy the universe and wonder about all its aspects, animate and inanimate, and whose activities continue to center on the eternal problem: man's place in the universe.

In addition to his outstanding astronomical accomplishments, Harlow Shapley is an all-around scientist, his field of scientific interest ranging from stars to ants. He tells in his book how, during his Mount Wilson days, he found that temperature can be read to within one degree, based on the rate at which ants run. He reports on his adventures with ants in different parts of the world, including the classical report of his experience during a big farewell feast given in Moscow by the Russians for sixteen visiting Americans after the end of World War II. At the dinner table Shapley observed two ants crawling off a bowl of bananas. He put them in a vodka-filled vial, to insure eternal happiness when the ants got to heaven, and added two fish eggs from a dish of caviar. Later, it appeared that only one ant was left. Mrs. Shapley gave what is probably the best explanation: people who go to vodka parties don't count very well.

On the occasion of Shapley's eightieth birthday a series of articles were written dealing with various aspects of his life and work: *The Galactocentric Revolution*, by Peter van de Kamp; *Harlow Shapley and Globular Clusters*, by Helen Sawyer Hogg; *On Some Problems of Interstellar Absorption*, by Carl Schalén; *Shapley's Research on the Magellanic Clouds*, by Bart J. Bok; *Harlow Shapley—Some Recollections*, by Hudson Hoagland (reprints available from the reviewer upon request).

Shapley's reaction to these efforts was touching and beautifully expressed: "Words are so thin in for-

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mulating a proper response to your kindness in celebrating me and my labors. You have done me proud, and have made it easier for future historians. I am getting better than I merit. My wish is that the gods treat you as well."

I shall end by mentioning Shapley's eightieth birthday party held a week later, on November 9, 1965, at the American Academy of Arts and Sciences in Brookline, Massachusetts. The "Great Blackout" could not dampen the spirit of the celebration, carried on partly by candlelight. The present reviewer made the party just in time, and afterwards composed a brief piano piece, the "Blackout Blues" (copies available on request).

Peter van de Kamp is Professor of Astronomy at Swarthmore College and Director of Sproul Observatory.

IN DEFENSE OF NATURE, by John Hay. *Little, Brown & Co., $4.95; 210 pp.* A PLACE IN THE WOODS, by Helen Hoover. *Alfred A. Knopf, $5.95; 292 pp., illus.*

There are still frontiers, at least in the sense that a person can find a world not yet wholly computerized, a world that maintains a degree of order and sanity and contact with the center and source of life itself. Here are the reports of two people who found such frontiers: totally different people, different reports, and different areas, but both looking for meaning, for some defense against the smother and crush of the hordes who have become the prisoners and servants of the machines.

John Hay went to the seashore to find his source and center, to sand and surging tides that are within easy reach of perhaps two-thirds of the people in this country. But John Hay found there more than a beach ball or a surfboard; he came back with more than a sunburn and sand in his shoes. Checking back, I find that I dog-eared more than thirty pages with notes to myself that each had something worth mentioning when I wrote this review. Thirty pages of 210 is phenomenal; half a dozen would have been better than average for a book that seemed important. At the very beginning, in an author's note, Hay points out that no one in his right mind can reject the technological world completely, but that "in us is the vision, the still miraculous organic experience, with which to meet the whole world of life, and not a half of it." And "there is a chance, paradoxically enough, to get rid of that terrible, isolating concept of man as the lord of creation."

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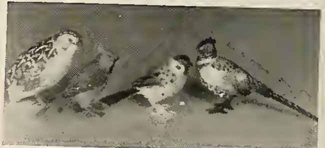

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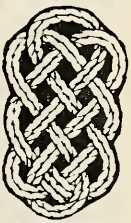

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blast at technology. It is essentially a plea for human sanity, for recognition of nature as the source and center of life and of man as a mere participant. His method here is to discuss and examine ideas and purposes, and in other sections to describe and appreciate differing areas of the coastland of the Northeast. He writes about the water, the waves, their impress upon the sand, the rocks, their seaweed and their barnacles, the salt marshes and their life, the winter storms and their impact, the fogs, the tides, the ways of the seas that cover so much of this earth. Wandering the coast from Long Island to Newfoundland, from summer to another spring, he celebrates nature the way a hard-headed naturalist should, without going into rhapsodies. These sections of his book are colorful, substantial, descriptive writing.

But it is primarily in the rather randomly alternated sections of philosophic and speculative writing that the real meat of the book is to be found. The descriptive parts are essentially illustrative material, the truth upon which the philosophy is based. After discussing the terrible consequences of uncontrolled use of DDT and its close chemical relatives, he says, "We alter, erase and poison the landscape at will . . . and hardly detect, let alone know how to identify, the damage, even when it affects our own bodies." And he says, "The resources we are now claiming and using up at a reckless rate are not only our own. They belong to the whole earth, and to all other organisms that use the light of the sun, the water and the soil for their substance. Without these other lives we would not last long." And "How will we survive our genius for invention coupled with our crazy willingness to destroy?"

The temptation to quote is great, but I shall skip on through those dog-eared pages to this: "It is already obvious that technological changes are at variance with our ability to keep up with them, that we are falling into violence, mistrust and confusion. We are in no position to boast about a manipulated future." And, finally, this: "Man against the natural world is man against himself."

This is a book that will be read slowly, reread, put on the shelf, remembered, taken down, and read again.

The other frontier book, as I have called these two, is by Helen Hoover, whose *The Gift of the Deer* received proper praise three years ago. This is the account of how Mrs. Hoover and her husband quit the city, Chicago, bought a cabin, and settled in for year-round life on the fringe of Minnesota's northernmost wilderness. Neither of them was experienced in rural living. Mrs. Hoover was a research metal-

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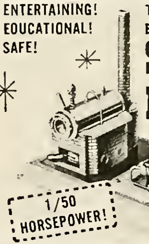

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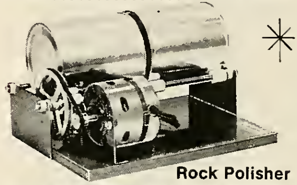

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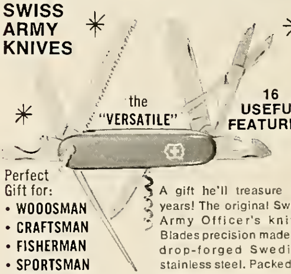

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lurgist; Mr. Hoover, a commercial artist. They made dozens of mistakes, were the victims of at least as many unavoidable circumstances. And they had their share of troubles with problems they inherited with the cabin and its acres—the crumbling foundation, the leaky roof, the lack of winter warmth in the more pretentious summer place they bought on adjoining land. And the financial problems—virtually all who quit the city for the country, hoping to earn their way somehow there, face this test sooner or later. The Hoovers hung on and won out—through her writing, his art, and their dogged determination, which is the critical element in every such venture.

Mrs. Hoover doesn't minimize the problems or fail to give them their full dramatic value. She doesn't philosophize about them, really, except in her foreword, and even there she dwells rather upon her approach to nature and writing about it. She discusses "two bugaboos . . . in the hope that this may lead to a better understanding of both my wild friends and me." They are anthropomorphism and teleology, and she seems still to be smarting about some things that were said about *The Gift of the Deer*. She has been at this nature-watching, nature-writing business less than fifteen years. Perhaps in another ten or fifteen years she will have mellowed a bit and be less defensive. There always will be advocates on both sides of anthropomorphism and teleology, even fanatics, and we who write have to endure them when they turn critics.

To the naturalist, the most fascinating parts of this book are those about how the Hoovers persuaded weasels and even fishers to come to them and eat from the hand. Evidently the taming of the weasels was the beginning of the nature observation that led to nature-writing and, eventually, to sales and security. To the general reader the trials and tribulations of the newcomer to the country will be the reward, though a good many country folk may wonder why they didn't find quicker or easier solutions. Either way, it is a book full of good reading for the armchair pioneer.

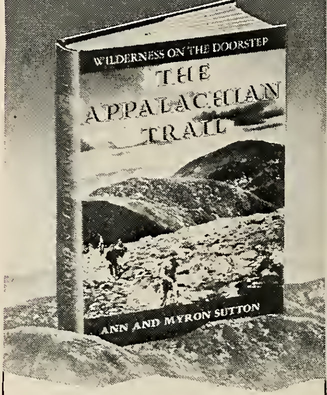
The illustrations by Adrian Hoover, the husband in this pioneering, are particularly good, as are his illustrations for all of Helen Hoover's books.

HAL BORLAND
Author and Naturalist

MYSTERIES OF EASTER ISLAND, by Francis Mazière. *W. W. Norton & Co., Inc., $6.95; 224 pp., illus.*

Enigmatic Easter Island has stimulated an astonishing number of printed words. Many have been misleading and to these, Mazière's book

"A magnificent achievement"*



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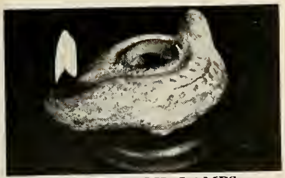

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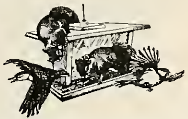

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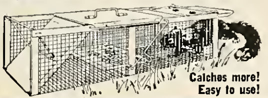

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contributes far more than its share. The account describes the residence of the author, his Tahitian wife, and an English companion on the island during nine months of 1964. The local history is rehashed, legends are retold, archeological monuments and "excavations" are described, life among the islanders is discussed, and the author's unsupported opinions and speculations are liberally interlarded.

The description of the island's already well-known monuments is redundant and in some cases so inaccurate that it is difficult to believe that Mazière really saw them. For example, the famous outdoor altar at Vinapu is described as a fortification with defensive walls.

Excavations carried out at the great statue quarry at Rano Raraku are made to appear much more extensive than they actually were and add nothing to our knowledge. Mazière carefully does not mention that his irresponsible digging caused one of the irreplaceable statues to be broken. His discussion of the manner of transportation of the statues contributes nothing, and his serious consideration of the idea that they were moved by "electro-magnetic or anti-gravitational forces" is ludicrous.

Much of the book is made up of local legends, which he says were collected by himself or by his wife. Some renderings are so similar in detail to those previously published by the late Father Sebastian Englert, the island priest, as to evoke doubts about their source. Mazière boasts of his close rapport with the islanders—enhanced, he says, by his wife's knowledge of the old form of the language. This is quite different from the speech of today and also from Tahitian. One wonders where she learned it. The remarkable number of errors in his rendering of local words (I counted thirty-five examples) casts further doubt on his assertion.

One of the book's most disagreeable aspects is its repeated and untruthful attempts to discredit both the Chilean administration of the island, which welcomed him, and Father Sebastian Englert, who aided him at every turn. Perhaps his attitude stems from his manifest French ethnocentrism and from the highly prudent official supervision of his field activities. His repeated remarks about the miserable condition of the islanders are false, and such items as his photograph of a child sleeping on a totora mat appear deliberately intended to convey the false impression that the children have no beds. Easter Island's remoteness and the difficulties of transportation have

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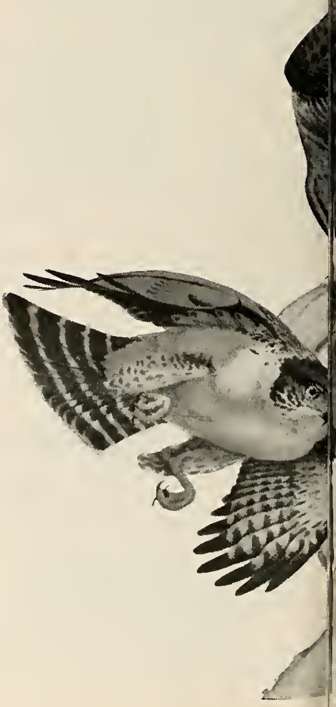
WILLIAM MULLO
University of Wyoming

EAGLES, HAWKS AND FALCONS OF TH WORLD, by Leslie Brown and Dean Amadon. *McGraw-Hill Book Co., $59.50; 2 vols., 945 pp., illus.*

This book is essentially an encyclopedic review of our much scattered knowledge of the 266 species of diurnal birds of prey in the world. It also incorporates the unpublished observations of dozens of ornithologists in both hemispheres and, for the first time, presents illustrations of each species and of many subspecies in one of the most interesting groups of the class Aves.

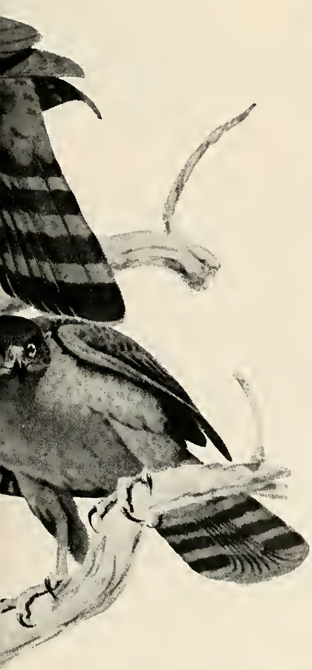
The work is formally divided into two parts, although three can, with some logic, be noted here. Part I consists of 17 introductory chapters on the



ology of the diurnal birds of prey. iese 137 pages also contain three mmarizing tables on wing loading id longevity and 33 figures that, nong other things, excellently illus- ate displays found in this group of ten spectacular birds. These chapters ill certainly interest amateur ornithol- gists and will be "must" reading for iy student beginning a field study of bird of prey.

The bulk of this book, Part II, is iven over to species-by-species ac- ounts, covering range, description (in- luding data on subspecies), field char- cters, voice, general habits, food, and reeding habits. Interspersed among iese 704 pages are 165 magnificent lates, most in full color, portraying he major variants in adult and first- nmature plumages. Drawn by eight rtists (Coheleach, Eckelberry, Gil- ert, Harrison, Kelly, Peterson, Reid- lenry, and Sandford), these plates are he crowning achievement in this won- lerful book. A number of species are llustrated in color for the first time, ind many of these illustrations are ruly superb.

A third section of this volume, con-



Guy Coheleach's painting of Bicoloured Sparrow-hawks.

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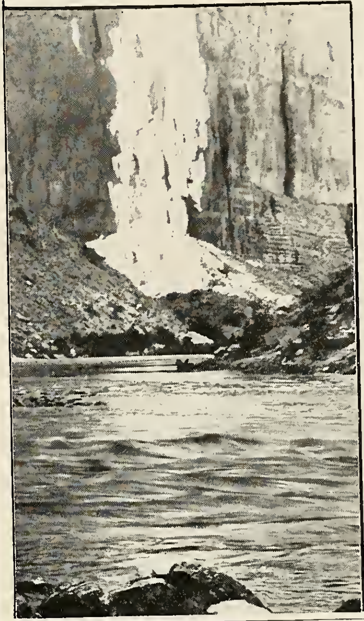

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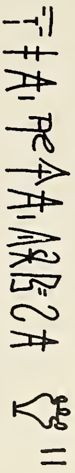

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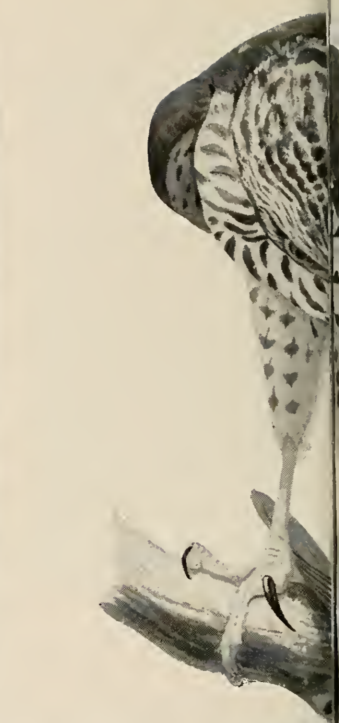

Sharp-shinned hawk with prey was painted by artist A. E. Gilbert.

sisting of 94 distribution maps, follows the text of Part II and shows ranges down to subspecies. Most of these maps have never before been figured, and their compilation on 70 pages is a scholarly achievement of high order. While segregation of these materials into a single section has clearly simplified editorial problems of layout, readers who are merely scanning the plates may miss quick clues to even the continental distribution of birds that are unfamiliar to them.

The work concludes with a 6-page supplementary bibliography (most of the references follow the species' treatments in Part II), helpful diagrams for field identification, and a 12-page index set (horribly, I think) in small (6-point) type as if the Table of Contents were complete—which it, lamentably, is not.

Started, apparently, as an attempt to bring together "all the available knowledge" on the diurnal birds of prey, this book is clearly a tight condensation and a suggestive guide to an enormous literature. The text reads easily and is

largely uncluttered by references, a format that may disconcert the scholarly reader. The authors' partnership, however, brings together the authority of Brown's extensive field experience in two hemispheres and Amadon's veteran grasp of avian taxonomy and the worldwide literature of ornithology. Their book is packed with facts handled critically, and for many species it is able to point out much that remains unknown. It is sure to stimulate research on this interesting group of birds as well as an interest in their preservation.

And many of the book's plates will be a joy forever.

JOSEPH J. HICKEY
University of Wisconsin

THE PRAIRIE WORLD, by David F. Costello. *Thomas Y. Crowell Co., $7.95; 242 pp., illus.*

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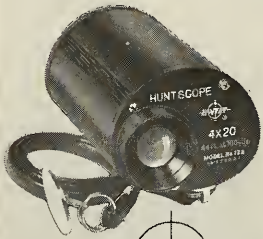

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tion. Born in the prairie state of Nebraska, student of the great ecologist Henry Cowles at Chicago, friend and associate of such distinguished students of the American grasslands as Homer Shantz, Frederic Clements, and John Weaver, his many years of government service have been given to the study of rangelands.

The experience of his fellow workers is largely preserved (not to say embalmed) in technical publications. We can be grateful that he has written, out of fullness, a book that should (and I predict will) be read with interest by generations to come. Like the classic naturalists, he has written with style and feeling of what he has seen at first hand; more than that, he has lived through decades of dramatic change, viewing them in the light of scientific knowledge not available to his predecessors in a great tradition. To these advantages must be added another not enjoyed by Gilbert White, Izaac Walton, or Charles Darwin—a superb photographic record.

The structure of his book is clear and direct, passing from a general description of the prairie world to a review of its plant life and animals, great and small, and on to an account of the impact of modern man. A final section, an appendix, tells where specimens of this vanishing community can still be seen; for assuredly it has suffered more from exploitation than the forest, a much earlier subject of public and private concern.

In a brief introduction Dr. Costello notes the diversity, beauty, and complexity of the great interior grasslands and the intricate relationships of environment and life that they represent. "This," he says, "is a book about one of the great heritages of man, the grassland on which we have built a civilization and from the soil of which we feed ourselves and . . . other people in the world. It is concerned with the prairie past and present."

Having myself spent more than a score of years in the grassland province, I can support his estimate of its fundamental importance to our economy. I too regret the sectionalism of metropolitan America, which has obliged the people of the rural midland to wage a continuing battle for political and economic justice. This is even to be seen in the meager support given to grassland scientists compared to that available for research and development leading to mass production of industrial utilities.

Appropriately, the first chapter of *The Prairie World* has the title of a figure used by another child of the prairie, Willa Cather. In this chapter, "The Grassland Sea," Dr. Costello

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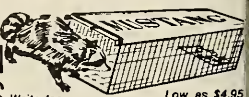

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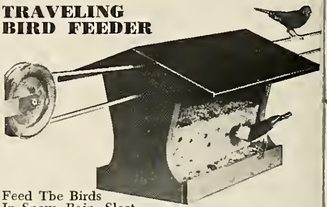

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The substantial midsection of the volume deals, as we have said, with the life of the grasslands. Both amateur and professional readers should be grateful for the coupling of common and scientific names, done in a way that is enlightening without being pedantic. A tragic theme is, of course, the wanton destruction of a once rich habitat and the intricate web of life that it sustained.

The final chapters tell how the vicissitudes of inevitable drought, which had been met through the ages by the grassland community, were tipped into catastrophe by reckless human exploitation. Here words are vividly re-enforced by pictures, including one of the finest views of a dust storm that I have ever seen. Yet the gloom of this account is lightened by a lesson that perhaps may not come too late—the marvelous resilience of natural communities of plants and animals as compared to the brittleness of historical human systems.

For assuredly there exists in nature a model—a model in the economy of energy and materials—that must be approximated by the cultures of man if they are to survive into the long and uncertain future.

Paul B. Sears
Ecologist

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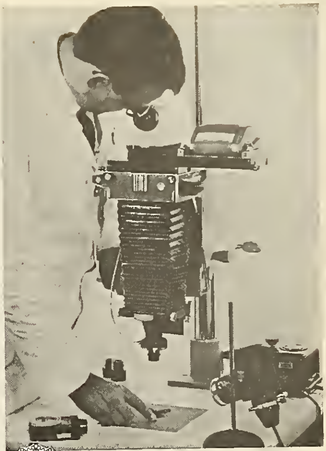

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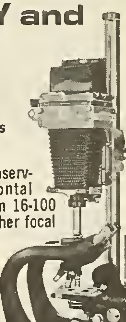

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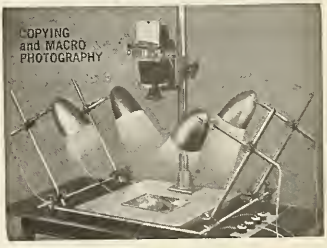

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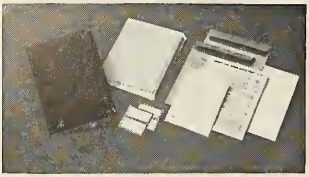

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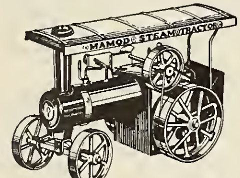

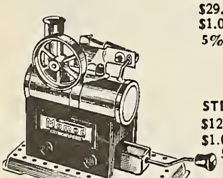

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THE REALITY OF THE PILGRIM FATHERS

PILGRIM COLONY: A HISTORY OF NEW PLYMOUTH 1620-1691. G. D. Langdon, Jr. Yale University Press, New Haven, 1966.

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HUSBANDMEN OF PLYMOUTH: FARMS AND VILLAGES IN THE OLD COLONY 1620-1692. D. B. Rutman. Beacon Press, Boston, 1967.

THE ECOLOGY OF A RESERVOIR

DEATH OF THE SWEET WATERS. D. Carr. W. W. Norton & Co., New York, 1966.

PRINCIPLES OF MICROBIAL ECOLOGY. T. D. Brock. Prentice-Hall, Inc., Englewood Cliffs, 1966.

ALGAE IN WATER SUPPLIES. C. M. Palmer. Public Health Service Publication No. 657, Department of Health, Education and Welfare, Washington, 1962.

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U.S. GEOGRAPHICAL AND GEOLOGICAL SURVEY OF THE ROCKY MOUNTAIN REGION. C. E. Dutton. Government Printing Office, Washington, 1879-80.

STANDING UP COUNTRY: THE CANYON LANDS OF UTAH AND ARIZONA. C. G. Crampton. Alfred A. Knopf, Inc., New York, 1964.

BEYOND THE HUNDREDTH MERIDIAN. W. Stegner. 8 vols. Houghton Mifflin Company, Boston, 1954.

NIGHT OF THE PALOLO

THE PALOLO WORM, EUNICE VIRIDIS (GRAY). W. McM. Woodworth. *Bulletin of the Museum of Comparative Zoology at Harvard College.* Vol. LI, No. 1, 1907.

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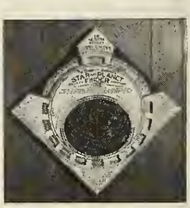

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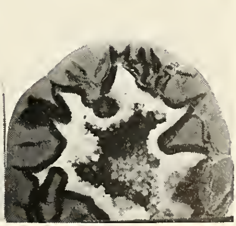

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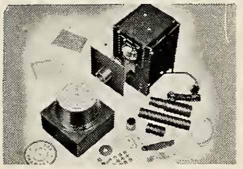

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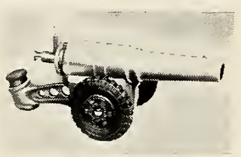

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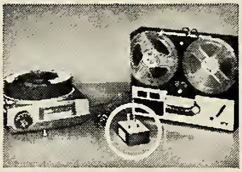

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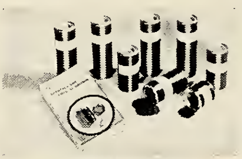

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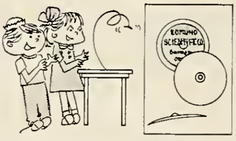
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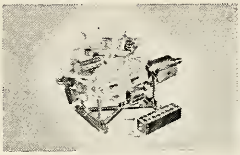

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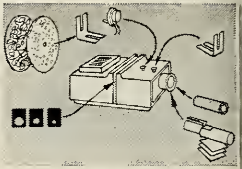

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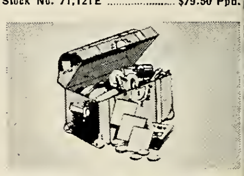

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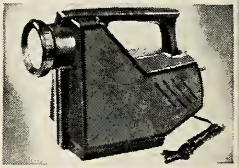

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Projects illustrations up to 3" x 3½"—enlarges them to 35" x 30" if screen is 6½ ft. from projector, larger pictures if screen is farther away. Use in darkened room for best results. Designed for children's use. No film or negatives needed. Projects charts, diagrams, color or black-and-white. Operates on 115 volts A.C. current . . . 6 ft. extension cord and plug included. Operates on 60 watt bulb, not included. Size 12" x 8" x 4½" wide. Weight 1 lb. 2 ozs. Plastic case.

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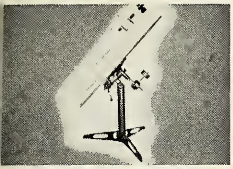

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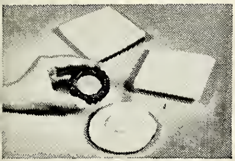

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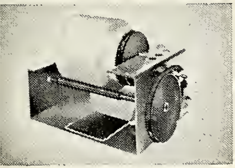

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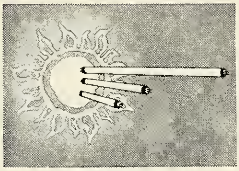

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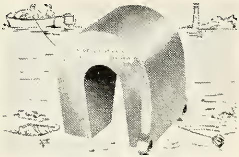

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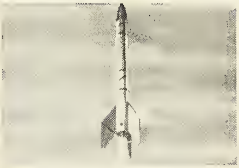

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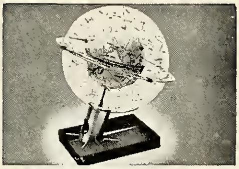

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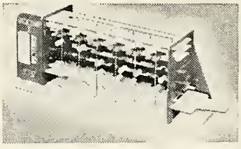

Working Model Digital Computer

Solve problems, teach logic, play games with miniature version of giant electronic brain! Adds, subtracts, multiplies, shifts, complements, carries, memorizes. Colored plastic parts easily assembled. 12" x 3½" x 4¾". Incl. step-by-step assembly diagrams, 32-p. book covering operation, computer language (binary system) programming problems & 15 experiments.

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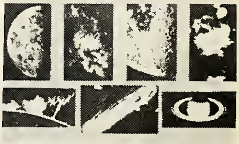

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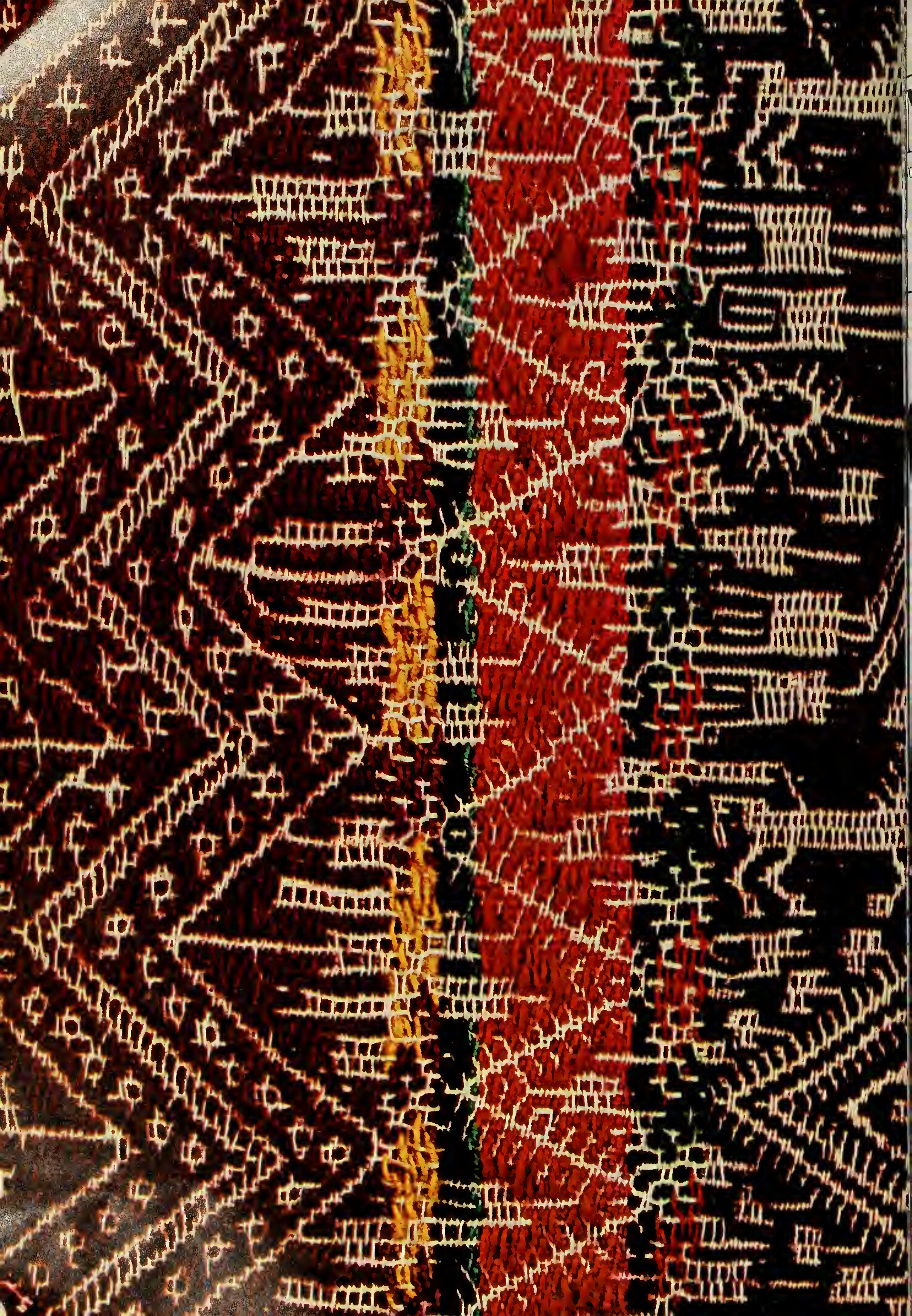

NATURAL HISTORY

OL. LXXVIII, No. 10 INCORPORATING NATURE MAGAZINE DECEMBER 1969

THE JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

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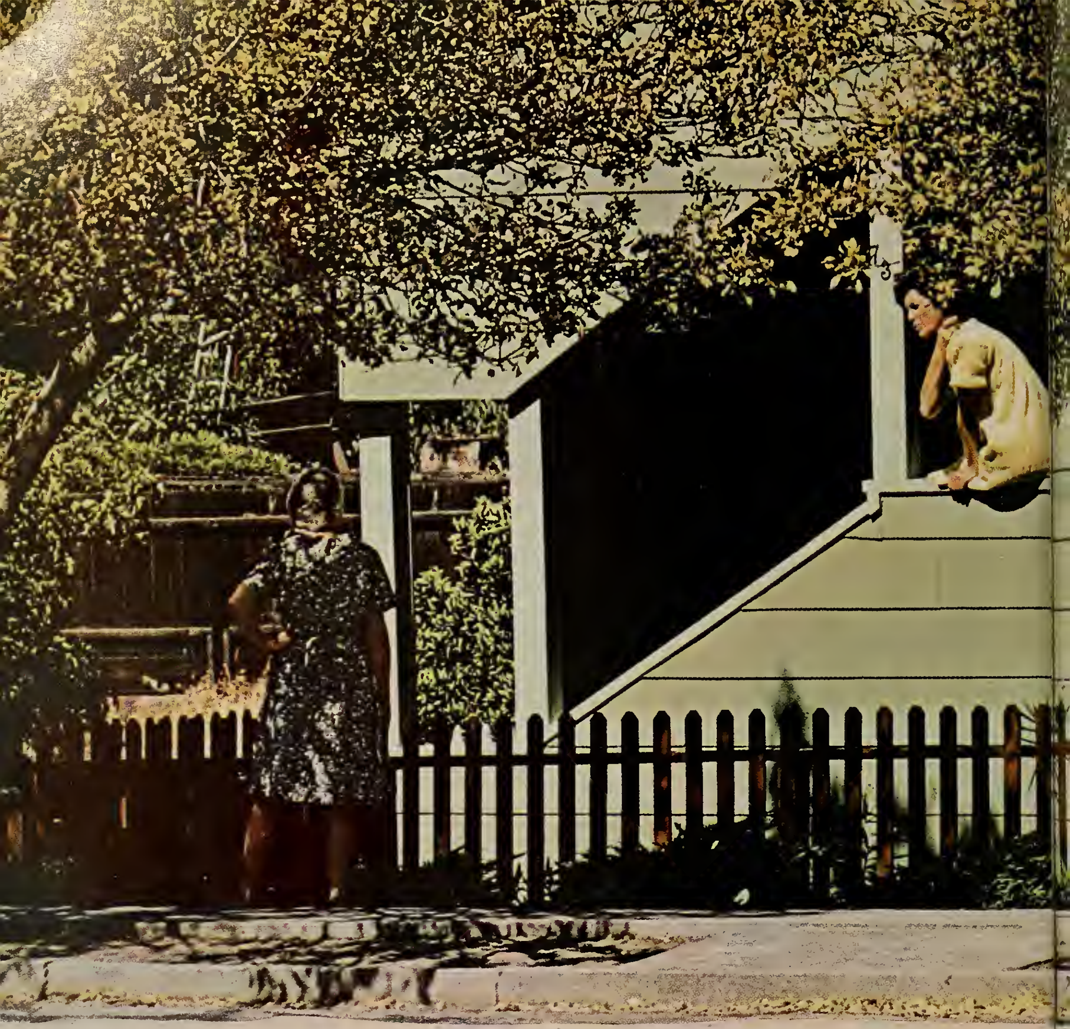

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which to measure change.

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and less to clean up. For each gallon of gasol
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of cooling water. Thanks to air-cooling and
ter recirculation, Benicia uses only one.

“How’s the fishing off the refinery?”
asked. “Fine” said the mayor. “We hook s
geon, bass and flounder. And sometimes we
a salmon.”

he refinery was there.”

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As for the air and the peace, our headline id picture surely say enough. But there's one effect of the refinery that every Benician notices. It has quintupled the city's tax base.

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THE AUTHORS

Gerald Carson, author of "The Most Celebrated Dog Case Ever Tried in Johnson County, Missouri, or the World," is a professional writer and social historian who is interested in the study of human attitudes toward animals. Mr. Carson is the author of numerous books, including *One for a Man, Two for a Horse* and *Cornflake Crusade.*

A citizen and former resident of Canada, anthropologist **Richard Borshay Lee** received his B.A. and M.A. from the University of Toronto, and his Ph.D. from the University of California at Berkeley. Dr. Lee's "Naturalist at Large" column, "Eating Christmas in the Kalahari," is the result of three years of field work with the !Kung Bushmen in Botswana (1963-64, 1967-69). A Research Fellow in Social Relations at Harvard University, he is presently working on the analysis and write-up of anthropological data on the social organization, ecology, kinship, and nutrition of Botswana. Dr. Lee's article, "Trance Cure of the !Kung Bushmen" appeared in NATURAL HISTORY in November, 1967. He also coedited (with Irven DeVore) *Man the Hunter*, published by Aldine Publishing Company in 1968.

Her several years of residence in Peru and Bolivia and her frequent contact with Indian culture provided **Grace Goodell** with the background for her article on weaving. Following two years of Peace Corps service with the Ministry of Agriculture in rural Andean Peru, 1965-67, she did field work for Dr. Junius Bird of The American Museum in the Cuzco area of Peru and in Bolivia. Currently a doctoral candidate in applied anthropology at Columbia University, Miss Goodell plans to work in the field of education for rural underdeveloped areas.

A 1926 graduate of the University of Leningrad, Soviet geographer **Innokenti P. Gerasimov** works in the field of the genesis, geography, classification, and mapping of soils. His particular interest involves the interaction of endogenic and exogenic forces and the relief-forming role of the movements of the earth's crust. Elected Academician in 1953, Gerasimov is presently Director of the Institute of Geography of the USSR Academy of Sciences and Chairman of the Soviet Geographers' National Committee. During the last few years, he has been actively concerned with the practical application of modern research methods in geography. Professor Gerasimov is the author of several hundred articles on geomorphology, soil science, paleography, nature protection and transformation, and the restoration of natural resources.

David P. Willoughby, the author of "Animal Ages," traces his interest in animals back many years to his father's experiences as a hunter and trapper in the woods of Minnesota and Manitoba. An Honorary Associate in Vertebrate Paleontology at the Los Angeles County Museum of Natural History, Mr. Willoughby is the author of "The Gorilla—Largest Living Primate," which appeared in *Scientific Monthly*, January, 1950, and "The Vanished Quagga," NATURAL HISTORY, February, 1966. His avocations include reading, research, and drawing.

Professor of Seismology at the California Institute of Technology, **Charles F. Richter** has been affiliated with the Seismological Laboratory in Pasadena since 1927. He was a Fulbright research scholar at the University of Tokyo from 1959 to 1960. Dr. Richter is coauthor with the late Beno Gutenberg of a series of papers, "On Seismic Waves," as well as of "Seismicity of the Earth," now a standard reference work. His instrumental magnitude scale for earthquakes, first published in 1935 and now commonly known as the "Richter scale," is a system of tables and charts for reduction of the indications of instruments. President of the Seismological Society of America, 1959-60, Dr. Richter's latest major paper is "Contemporary Tectonic Changes."

The most celebrated dog case ev

by Gerald Carson

It is generally agreed that the dog was the first animal to be domesticated by man, probably because of the clear advantages of a mutual-assistance pact based upon cooperation in the search for food. The dog had the nose. The man had the eyes. The dog was faster, the man more cunning. At any rate, social relations developed between these two, and man found that he could not, or at least would not, get along without the dog. The Egyptians named the brightest star in the heavens the dog star, Sirius. Well-placed Romans kept a dog in the atrium and set in the walls of their dwellings a mosaic or drawing calling attention to the watchdog's fidelity in the words *cave canem*—"beware of the dog." A legal doctrine even developed in English jurisprudence to the effect that a dog's character was presumed to be good until the contrary was shown. But the greatest literary tribute extant to the qualities of man's ancient companion waited upon a court drama that was played out in a small, dingy courtroom in west central Missouri. The year was 1869, a time when the average rural American believed implicitly in his watch, the patent medicine of his choice, and his own, personal dog. The central figure in the Missouri case was "Old Drum," a black-and-tan foxhound, with perhaps a little bloodhound in him, who was executed as a supposed killer of sheep, five miles southwest of the hamlet of Kingsville in Johnson County—near the Cass County line. Old Drum found his agony and apotheosis on a still October night and lives on today as a part of our national memory and in Missouri's dusty legal reports disguised as *Charles Burden, Respondent* v. *Leonidas Hornsby, Appellant.*

Game was still abundant in the post-Civil War years along the heavily timbered ridges of Johnson County, and Charles Burden, farmer, woodsman, and hunter—a character right out of James Fenimore Cooper—kept a pack of hounds for the chase. Old Drum was the leader and favorite, *primus inter pares*—"first among equals." Some dogs would follow false trails. But not Drum. Burden knew from his bugling music, sounding from the woodlots or tangled undergrowth, what kind of game Old Drum had flushed. In the vernacular of the hunter, the dog "never lied."

"He was good for varmints, wolves, and such like," Burden said, "and was as good a deer dog as I ever had. . . . Money wouldn't have bought him."

If you are familiar with the habits of the Missouri hound dog, you know that he lies around the place all day, sunning himself, snapping at flies, languidly scratching, apparently no good to himself or anyone else—a real hard-core welfare type. But about dusk he gets restless, yawns, stretches, and soon is ready to hit the trail. On the morning of October 28, Charles Burden, at peace with himself and the world, rode through the glories of the Missouri autumn past the house of his brother-in-law, "Lon" Hornsby, who raised sheep and cattle about a mile north of his own farm; and on to the post office and general store at Kingsville. He returned by the same road to be greeted as usual by Old Drum who leaped upon him, licking his hands and wagging an eager welcome. These were all little details that Burden recalled later. For that night Old Drum met his death and became the subject of legal battles that occupied the attention of four courts before the controversy ended.

It was after sundown. Burden and a neighbor were sitting in the dusk at the front of the house, smoking some of Burden's home-grown tobacco, listening to the baying of the pack. Joyous melody announced to their practiced ears that a fox was up and running across the open prairies, along a wooded creek, and into the hills; Old Drum was in the lead, as usual. Suddenly, at about eight o'clock, Burden heard a gunshot. It came from the direction of Hornsby's farm. There was silence. Then the dogs were baying again. But Old Drum's voice was missing. Burden jumped to his feet, ran to get his hunting horn, and blew several blasts. All the dogs returned except one. Old Drum was not among them.

The next morning Burden saddled up and called on Lon Hornsby, a small, wiry man with flaming red hair and a quarrelsome disposition. During the summer and fall Hornsby had lost a number of sheep, killed by marauding dogs that had also raided his smokehouse. Hornsby had sworn that he would kill the first strange dog he found on his premises. He was making cider when Burden rode up.

"Lon, have you seen anything of my dog Drum around here?" When Hornsby said no, Burden persisted. "What dog was that you shot last night?" Hornsby acknowledged that he did have Dick Ferguson, his young nephew, shoot at a stray dog, "a black-looking dog," but the gun was only loaded with grains of corn, just to scare the rascal. Besides, everybody knew that Drum was not black, but had a black-and-tan coat.

Nevertheless, Old Drum was dead. Burden found him just above the ford on Big Creek below Haymaker's mill—about a mile from Hornsby's farm—lying with his head in the water. His body was filled with buckshot. There was mud on his underside, and there were sorrel hairs on the body, indicating that he had been transported and dragged some distance. Hornsby owned a sorrel mule. The evidence was circumstantial, but Burden brought suit for damages before a justice of the peace at Kingsville. One jury failed to come to an agreement, but in a second trial Burden won the verdict. A curious historical footnote to the trial is that one of Hornsby's attorneys was David Nation, later the husband of the muscular temperance fanatic and mystic Carrie Nation, who wielded her little hatchet so destructively in the hotel bars and saloons of Kansas.

Hornsby appealed to the Johnson County Court of Common Pleas at Warrensburg where in March, 1870, the earlier decision was upset. With Hornsby now ahead, it was neighbor against neighbor throughout the

ied in Johnson County, Missouri— or the world

community. Threats were made on both sides. One Hornsby witness was warned that he would be horsewhipped if he persisted in his testimony, and he prudently disappeared. Refusing to give up, Burden hired the Sedalia, Missouri, law firm of John F. Phillips and George Graham Vest, then the leading lawyers in that part of the state. The former later became a federal judge, the latter, a United States senator.

A new trial was obtained on the ground of new evidence. Once again the whole countryside gathered for court day in the old courthouse on North Main Street in Warrensburg. Everybody was on tenterhooks to know what a jury of farmers and fox hunters would do about convicting or exonerating Old Drum. Hornsby was also represented by able counsel, Thomas T. Crittenden, who later became governor of the state and broke up the Jesse James gang of outlaws, and Francis Marion Cockrell, who later served along with his adversary, Vest, in the United States Senate. Together, these men were known as the "Big Four" of the Missouri bar.

The most colorful figure in the courtroom was Vest, the Kentucky-born descendant of Scotch-Irish Presbyterians from Virginia. He was a graduate of Center College in Danville, Kentucky, and had read law in the office of James Harlan, lawyer, legislator, and attorney general of Kentucky, and father of John Marshall Harlan, who became an associate justice of the U.S. Supreme Court. In 1852, Vest graduated from the law department of Transylvania University. He settled in Missouri in 1859, entered into political affairs and was a Democratic Presidential elector on the Douglas ticket. When the Civil War came, Vest enlisted in the Confederate Army and, toward the end of the war, sat in the Senate of the Confederate States. A few years after the Old Drum case, Vest was elected to the U.S. Senate, thus acquiring the distinction of having sat in the highest legislative body of two nations.

At the time of the litigation over Old Drum, Vest was forty years old, one of the coming men of the state, an accomplished stump speaker—witty and emotional by turns—at his best in pleading before a jury, where he demonstrated a mastery of the forensic style then greatly admired. The trial was held on a rainy night in the dim light of kerosine lamps. Many witnesses were heard, including Hornsby's nephew, Dick Ferguson, who ingenuously declared on the witness stand, "My stars! I haven't seen Old Drum since I shot him." During this trial, according to the *Kansas City Star*, in a retelling of the story, "more oratory was turned loose than was ever heard in the most celebrated murder case ever tried in a Missouri court."

All of the arguments have long been forgotten, except Vest's closing appeal. A man of medium height and slender build, with a large head, drooping mustache, magnetic eyes, and great charm of manner, Vest had up to this time taken only a minor part in the proceedings. But now it fell to him to sum up the case against Hornsby. Gravely addressing the presiding judge in the traditional words, "May it please the Court," Vest began to speak quietly and earnestly. He ignored the testimony. For about an hour he ranged through

A TRIBUTE TO THE DOG
(BY SENATOR GEORGE GRAHAM VEST)
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18

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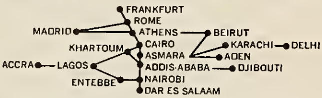

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history, poetry, legend, and classical literature calling attention to sagacious and faithful dogs whom men have loved, quoting from the Biblical account of the dogs who came to lick the sores of the beggar Lazarus; citing Byron's line in *Don Juan,* " 'Tis sweet to hear the honest watchdog's bark' "; and the graphic description in John Lothrop Motley's *The Rise of the Dutch Republic* of how a dog had prevented the capture of William of Orange by the cruel Duke of Alva.

After pointing out the weaknesses in the arguments of opposing counsel and drawing attention to the law applicable to the case, Vest appeared ready to conclude. But then he moved closer to the jury box. He looked—someone remembered afterward—taller than his actual five feet six inches, and began in a quiet voice to deliver an extemporaneous peroration. It was quite brief, less than four hundred words.

"Gentlemen of the jury," Vest said, "the best friend a man has in the world may turn against him and become his worst enemy. His son or daughter that he has reared with loving care may prove ungrateful. Those who are nearest and dearest to us, those whom we trust with our happiness and our good name, may become traitors to their faith. The money that a man has, he may lose. It flies away from him, perhaps when he needs it the most. A man's reputation may be sacrificed in a moment of ill-considered action. The people who are prone to fall on their knees to do us honor when success is with us may be the first to throw the stone of malice when failure settles its cloud upon our heads. The one absolutely unselfish friend that a man can have in this selfish world, the one that never deserts him and the one that never proves ungrateful or treacherous is his dog.

"Gentlemen of the jury, a man's dog stands by him in prosperity and in poverty, in health and in sickness. He will sleep on the cold ground, where the wintry winds blow and the snow drives fiercely, if only he may be near his master's side. He will kiss the hand that has no food to offer, he will lick the wounds and sores that come in encounters with the roughness of the world. He guards the sleep of his pauper master as if he were a prince. When all other friends desert he remains. When

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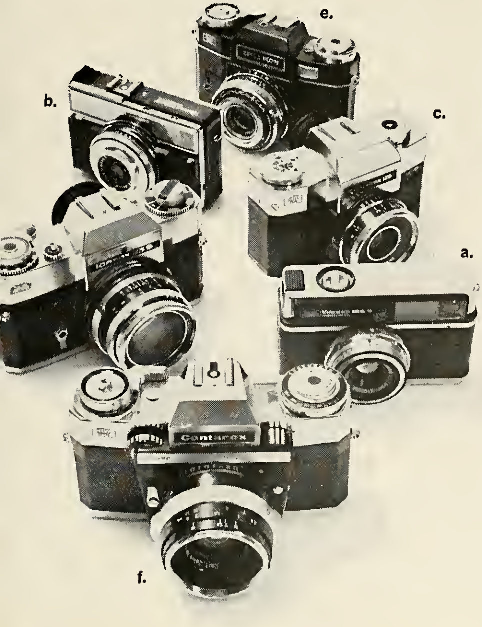

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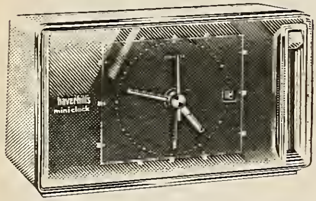

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riches take wings and reputation falls to pieces, he is as constant in his love as the sun in its journey through the heavens. If fortune drives the master forth an outcast in the world, friendless and homeless, the faithful dog asks no higher privilege than that of accompanying him to guard against danger, to fight against his enemies, and when the last scene of all comes, and death takes the master in its embrace and his body is laid away in the cold ground, no matter if all other friends pursue their way, there by his graveside will the noble dog be found, his head between his paws, his eyes sad but open in alert watchfulness, faithful and true even to death."

When Vest had concluded, he bowed to the judge and sat down. The presiding justice was entranced. Great sobs shook the courtroom. Hounds of the Old Drum type were "folks," a part of the family, on the middle border a hundred years ago. For a magic moment the spectators were transported, uplifted by the loneliness and ultimate tragedy of all life that struck home to all who heard the appeal. Seeing themselves as in a mirror, the jury wept.

Crittenden, one of the adverse attorneys, leaned over to his associate Cockrell, and whispered, as he recalled later, that the dog, though dead, had won. He added, "we had better get out of the courthouse with our client, or all would be hanged." Vest's closing words, in which he depicted the "noble dog" at his master's grave, was not sheer hyperbole. Such a dog actually existed at the time in Scotland. His name was "Greyfriars Bobby" and he guarded the grave of his owner from 1858 to his own death in 1872. As Greyfriars Bobby's fame spread, the Lord Provost exempted him from the dog tax and a fountain was raised in his honor at Edinburgh by Angela, Baroness Burdett-Coutts, noted philanthropist and close friend of Queen Victoria. Another instance of the faithfulness of dog to man comes from nearer home. Lucien B. Kerr, Colonel of the Eleventh Illinois Cavalry, survived the Civil War but was fatally wounded in a hunting accident. The Irish setter that had accompanied him was inconsolable. While the Colonel lay near death at his home in Peoria, the dog, according to one account, stationed himself on the veranda outside the sick room. When Kerr refused amputation of his arm and died, the dog was allowed to enter the room. He put his paws on the bed, licked the face of his dead master, returned to his post on the porch, and died within the hour. Perhaps, from the perspective of a more skeptical age, this may be regarded as an instance of the pathetic fallacy. Perhaps the dog had the distemper. But it is a fact that on the northwest corner of Colonel Kerr's lot in Peoria's Springdale Cemetery, there is a reclining dog "true, even unto death," sculptured in sandstone.

The Old Drum jury took two minutes to return a verdict in favor of Burden and assess damages of $50. For his tribute to all dogdom, Vest received a fee of $10. Hornsby appealed to the Missouri Supreme Court, but his heart was not really in it, and when the decision of the lower court was affirmed, the case ground to an end. Old Drum had been vindicated and given a martyr's crown in what one law journal called "the most celebrated dog case in Johnson County, Missouri, or for that matter, in the world."

No court stenographer was present when Senator Vest pronounced his eulogy, and his words are sometimes referred to as the "Lost Speech." But it has been carefully reconstructed from notes taken by Crittenden and has survived, not because it was written or printed but, as Professor William Lyon Phelps once pointed out, "in the same manner as ancient epics, folk songs, ballads, cowboy choruses, sea chanteys, and lullabies." Vest's gem of sentiment on an aspect of the human–animal relationship has completely overshadowed his long and important career in the United States Senate from 1879 to 1903, a period when he had, according to the *Chicago Journal*, "half the brains of the Democratic side of the Senate." Vest opposed the high protective measures of his day, the acquisition of territory after the Spanish-American War, and on one occasion, thwarted an attempt by private interests to commercialize Yellowstone Park.

The eulogy was quickly recognized as a classic statement and has never disappeared from view since it was delivered. Some two years after Senator Vest's death in 1904, the speech was revived as a funeral oration over

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the grave of a dog, Pero, killed by an automobile in Denver. It became almost axiomatic for any attorney representing the owner of a slain animal to talk about men and dogs and what they mean to each other, invoking, of course, the memory of Old Drum. But courtroom procedures have changed with the passing years, and Old Drum may be near the end of his century of service so far as the higher courts are concerned. The Missouri Supreme Court recently set aside the conviction of a man who had killed another man's dog. The ruling was made on the ground that the lawyer for the dog's owner had improperly injected Old Drum into the case for its emotional effect upon the jury.

Regardless of what the courts may say about the legal proprieties, Old Drum has not lost his hold on the affections of dog owners. A bronze tablet has been attached to the wall of the old court house in Warrensburg, now the home of the Johnson County Historical Society, marking the scene as a historic site. Another monument stands on the banks of Big Creek just above the deer crossing where Drum was found after he was shot. The memorial includes in its construction rocks sent from most of the American states, the Great Wall of China, the white cliffs of Dover, Germany. France, Guatemala, Mexico, Jamaica. South Africa, the Virgin Islands, Panama, and the West Indies. The base bears a granite stone on which is incised the representation of a dog treeing a coon. A deer is being chased in one corner, a fox in the other. The lettering reads "Old Drum—Killed 1869." A bronze statue, executed by Reno Gastaldi, the St. Louis sculptor, stands on the lawn of the present court house, the model created from a study of some of the best hound dogs in the Middle West. It was dedicated in 1958 by the attorney general of Missouri and Captain Will Judy of Chicago, editor of *Dog World*. The text of the Old Drum speech appears on the marble base.

Burden and Hornsby eventually recovered from the economic effects of their litigation, were reconciled, and died in obscurity. But the dog they fought over seems destined to be remembered as long as men shall enjoy the companionship of a canine friend. ■

ary Carnwath isn't trying to save the world.
t a little piece of it.

: Hopi Indians' village of Ship-
in Arizona sits on land so poor,
e and inhospitable that so far no-
as tried to take it away from

ctricity has not yet reached the
Water must be hauled from
iles away. Jobs are few and far
Only poverty and despair are
y and in abundance.
: for the first time in generations,
Carnwath and people like her are
hope among the Hopis.
ry Carnwath works and lives
ousand miles away, in Manhat-
er own daughter is now grown-
l through Save the Children Fed-
she is sponsoring one of the
girls, 8-year-old Grace Mahtewa.
: Mahtewas (two parents, three
n, one grandmother and a sister-
live tightly packed in a tiny
d mud house. The father, who
ranch work but can't find any
f the year, isn't able to provide
ily with even the bare necessities.
ace, bright, ambitious and indus-

trious, would possibly have had to quit school as soon as she was old enough to do a day's work. But, because of Mary Carnwath, that won't be necessary.

The $15.00 a
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iding a remarkable number of
or Grace and her family.
ace will have a chance to con-
chooling. The family has been
make its home a little more liv-
small portion of Mary Carn-
contribution, together with
from other sponsors, was bor-
by the village to renovate a dilap-
building for use as a village cen-
e center now has two manual
machines that are the begin-
f a small income-producing busi-
's only a small beginning. More
and more people like Mary
ath are needed. With your help,
s this village program will pro-
nough money to end the Hopis'
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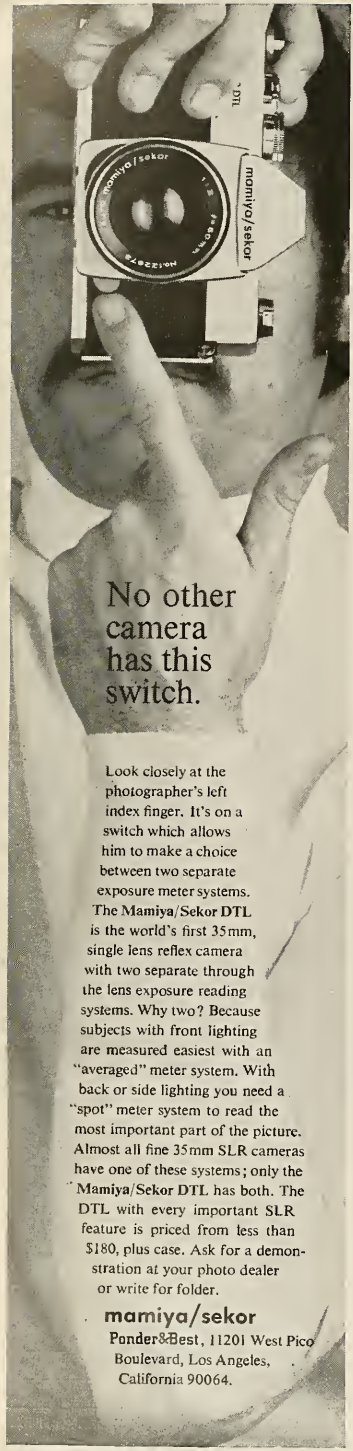
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A Naturalist at Large

Eating Christmas in the Kalahari

by Richard Borshay Lee

The !Kung Bushmen's knowledge of Christmas is thirdhand. The London Missionary Society brought the holiday to the southern Tswana tribes in the early nineteenth century. Later, native catechists spread the idea far and wide among the Bantu-speaking pastoralists, even in the remotest corners of the Kalahari Desert. The Bushmen's idea of the Christmas story, stripped to its essentials, is "praise the birth of white man's god-chief"; what keeps their interest in the holiday high is the Tswana-Herero custom of slaughtering an ox for his Bushmen neighbors as an annual goodwill gesture. Since the 1930's, part of the Bushmen's annual round of activities has included a December congregation at the cattle posts for trading, marriage brokering, and several days of trance-dance feasting at which the local Tswana headman is host.

As a social anthropologist working with !Kung Bushmen, I found that the Christmas ox custom suited my purposes. I had come to the Kalahari to study the hunting and gathering subsistence economy of the !Kung, and to accomplish this it was essential not to provide them with food, share my own food, or interfere in any way with their food-gathering activities. While liberal handouts of tobacco and medical supplies were appreciated, they were scarcely adequate to erase the glaring disparity in wealth between the anthropologist, who maintained a two-month inventory of canned goods, and the Bushmen, who rarely had a day's supply of food on hand. My approach, while paying off in terms of data, left me open to frequent accusations of stinginess and hard-heartedness. By their lights, I was a miser.

The Christmas ox was to be my way of saying thank you for the cooperation of the past year; and since it was to be our last Christmas in the field, I determined to slaughter the largest, meatiest ox that money could buy, insuring that the feast and trance dance would be a success.

Through December I kept my eyes open at the wells as the cattle were brought down for watering. Several animals were offered, but none had quite the grossness that I had in mind. Then, ten days before the holiday, a Herero friend led an ox of astonishing size and mass up to our camp. It was solid black, stood five feet high at the shoulder, had a five-foot span of horns, and must have weighed 1,200 pounds on the hoof. Food consumption calculations are my specialty, and I quickly figured that bones and viscera aside, there was enough meat—at least four pounds—for every man, woman, and child of the 150 Bushmen in the

EDITOR'S NOTE: *The !Kung and other Bushmen speak click languages. In the story, three different clicks are used:*

1. The dental click (/), as in /ai/ai, /ontah, and /gaugo. The click is sometimes written in English as tsk-tsk.

2. The alveopalatal click (!), as in Ben!a and !Kung.

3. The lateral click (//), as in //gom. Clicks function as consonants; a word may have more than one, as in /n!au.

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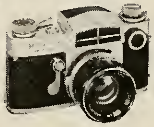

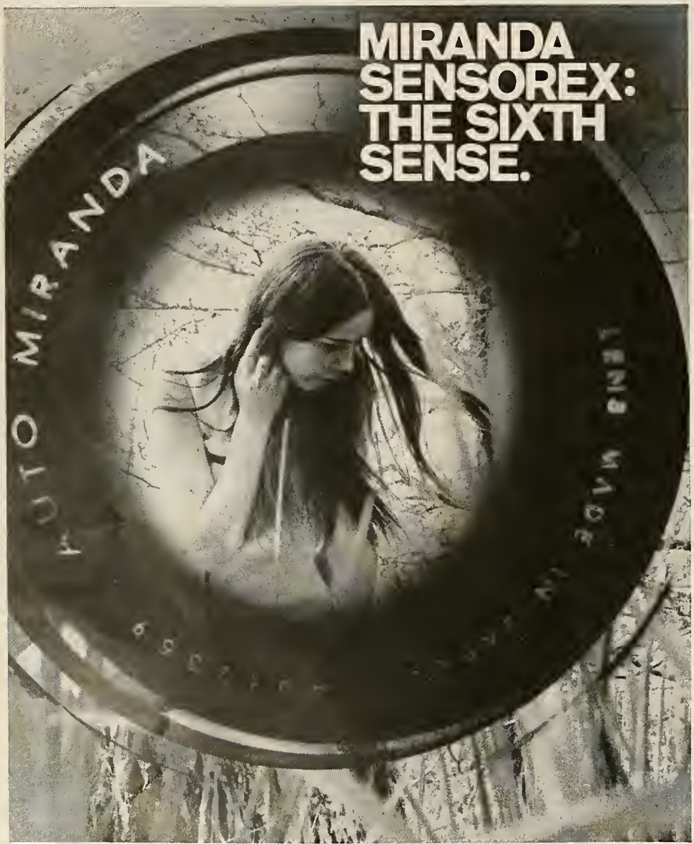
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vicinity of /ai/ai who were expected at the feast.

Having found the right animal at last, I paid the Herero £20 ($56) and asked him to keep the beast with his herd until Christmas day. The next morning word spread among the people that the big solid black one was the ox chosen by /ontah (my Bushman name; it means, roughly, "whitey") for the Christmas feast. That afternoon I received the first delegation. Ben!a, an outspoken sixty-year-old mother of five, came to the point slowly.

"Where were you planning to eat Christmas?"

"Right here at /ai/ai," I replied.

"Alone or with others?"

"I expect to invite all the people to eat Christmas with me."

"Eat what?"

"I have purchased Yehave's black ox, and I am going to slaughter and cook it."

"That's what we were told at the well but refused to believe it until we heard it from yourself."

"Well, it's the black one," I replied expansively, although wondering what she was driving at.

"Oh, no!" Ben!a groaned, turning to her group. "They were right." Turning back to me she asked, "Do you expect us to eat that bag of bones?"

"Bag of bones! It's the biggest ox at /ai/ai."

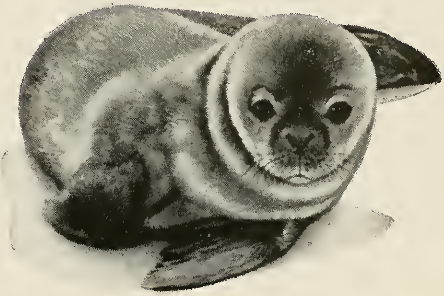
"Big, yes, but old. And thin. Everybody knows there's no meat on that old ox. What did you expect us to eat off it, the horns?"

Everybody chuckled at Ben!a's one-liner as they walked away, but all I could manage was a weak grin.

That evening it was the turn of the young men. They came to sit at our evening fire. /gaugo, about my age, spoke to me man-to-man.

"/ontah, you have always been square with us," he lied. "What has happened to change your heart? That sack of guts and bones of Yehave's will hardly feed one camp, let alone all the Bushmen around /ai/ai." And he proceeded to enumerate the seven camps in the /ai/ai vicinity, family by family. "Perhaps you have forgotten that we are not few, but many. Or are you too blind to tell the difference between a proper cow and an old wreck? That ox is thin to the point of death."

"Look, you guys," I retorted,



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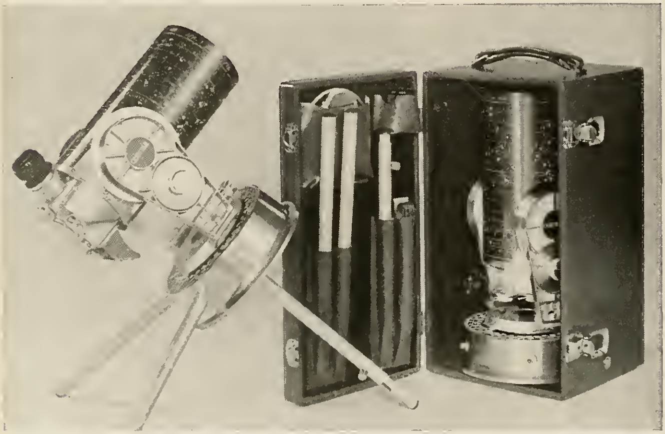

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"that is a beautiful animal, and I'm sure you will eat it with pleasure at Christmas."

"Of course we will eat it; it's food. But it won't fill us up to the point where we will have enough strength to dance. We will eat and go home to bed with stomachs rumbling."

That night as we turned in, I asked my wife, Nancy: "What did you think of the black ox?"

"It looked enormous to me. Why?"

"Well, about eight different people have told me I got gypped; that the ox is nothing but bones."

"What's the angle?" Nancy asked. "Did they have a better one to sell?"

"No, they just said that it was going to be a grim Christmas because there won't be enough meat to go around. Maybe I'll get an independent judge to look at the beast in the morning."

Bright and early, Halingisi, a Tswana cattle owner, appeared at our camp. But before I could ask him to give me his opinion on Yehave's black ox, he gave me the eye signal that indicated a confidential chat. We left the camp and sat down.

"/ontah, I'm surprised at you; you've lived here for three years and still haven't learned anything about cattle."

"But what else can a person do but choose the biggest, strongest animal one can find?" I retorted.

"Look, just because an animal is big doesn't mean that it has plenty of meat on it. The black one was a beauty when it was younger, but now it is thin to the point of death."

"Well I've already bought it. What can I do at this stage?"

"Bought it already? I thought you were just considering it. Well, you'll have to kill it and serve it, I suppose. But don't expect much of a dance to follow."

My spirits dropped rapidly. I could believe that Ben!a and /gaugo just might be putting me on about the black ox, but Halingisi seemed to be an impartial critic. I went around that day feeling as though I had bought a lemon of a used car.

In the afternoon it was Tomazo's turn. Tomazo is a fine hunter, a top trance performer (*see* "The Trance Cure of the !Kung Bushmen," NATURAL HISTORY, November, 1967), and one of my most reliable inform-

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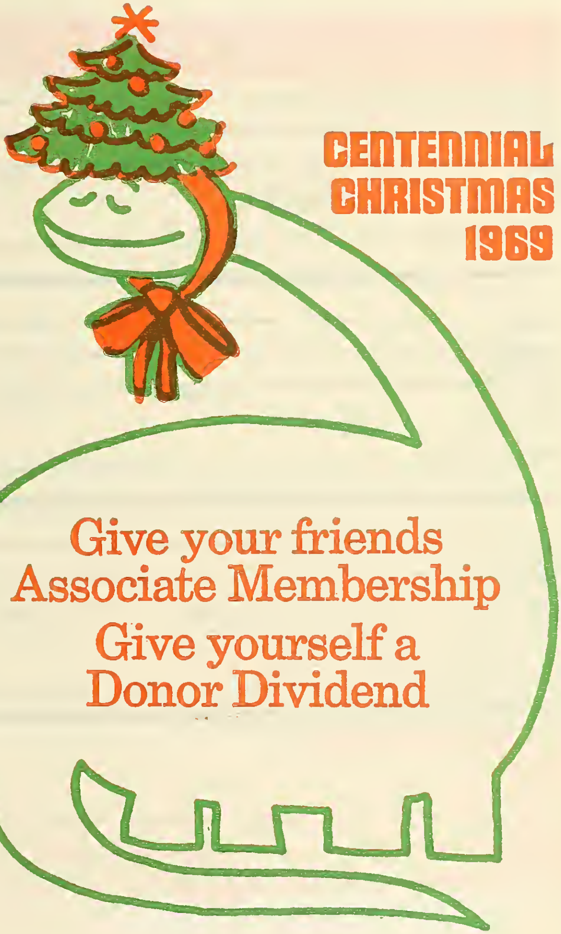

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TEAR OFF AND MAIL WITH YOUR REMITTANCE IN ATTACHED ENVELOPE ants. He approached the subject of the Christmas cow as part of my continuing Bushmen education.

"My friend, the way it is with us Bushmen," he began, "is that we love meat. And even more than that, we love fat. When we hunt we always search for the fat ones, the ones dripping with layers of white fat: fat that turns into a clear, thick oil in the cooking pot, fat that slides down your gullet, fills your stomach and gives you a roaring diarrhea," he rhapsodized.

"So. feeling as we do," he continued, "it gives us pain to be served such a scrawny thing as Yehave's black ox. It is big, yes, and no doubt its giant bones are good for soup, but fat is what we really crave and so we will eat Christmas this year with a heavy heart."

The prospect of a gloomy Christmas now had me worried, so I asked Tomazo what I could do about it.

"Look for a fat one, a young one . . . smaller, but fat. Fat enough to make us *//gom* ('evacuate the bowels'), then we will be happy."

My suspicions were aroused when Tomazo said that he happened to know of a young, fat, barren cow that the owner was willing to part with. Was Toma working on commission, I wondered? But I dispelled this unworthy thought when we approached the Herero owner of the cow in question and found that he had decided not to sell.

The scrawny wreck of a Christmas ox now became the talk of the /ai/ai water hole and was the first news told to the outlying groups as they began to come in from the bush for the feast. What finally convinced me that real trouble might be brewing was the visit from u!au, an old conservative with a reputation for fierceness. His nickname meant spear and referred to an incident thirty years ago in which he had speared a man to death. He had an intense manner; fixing me with his eyes, he said in clipped tones:

"I have only just heard about the black ox today, or else I would have come here earlier. /ontah, do you honestly think you can serve meat like that to people and avoid a fight?" He paused, letting the implications sink in. "I don't mean fight you, /ontah; you are a white man. I mean a fight between Bushmen. There are many fierce ones

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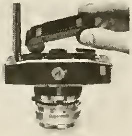

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SEYCHELLES

here, and with such a small quantity of meat to distribute, how can you give everybody a fair share? Someone is sure to accuse another of taking too much or hogging all the choice pieces. Then you will see what happens when some go hungry while others eat."

The possibility of at least a serious argument struck me as all too real. I had witnessed the tension that surrounds the distribution of meat from a kudu or gemsbok kill, and had documented many arguments that sprang up from a real or imagined slight in meat distribution. The owners of a kill may spend up to two hours arranging and rearranging the piles of meat under the gaze of a circle of recipients before handing them out. And I also knew that the Christmas feast at /ai/ai would be bringing together groups that had feuded in the past.

Convinced now of the gravity of the situation, I went in earnest to search for a second cow; but all my inquiries failed to turn one up.

The Christmas feast was evidently going to be a disaster, and the incessant complaints about the meagerness of the ox had already taken the fun out of it for me. Moreover, I was getting bored with the wisecracks, and after losing my temper a few times, I resolved to serve the beast anyway. If the meat fell short, the hell with it. In the Bushmen idiom, I announced to all who would listen:

"I am a poor man and blind. If I have chosen one that is too old and too thin, we will eat it anyway and see if there is enough meat there to quiet the rumbling of our stomachs."

On hearing this speech, Ben!a offered me a rare word of comfort. "It's thin," she said philosophically, "but the bones will make a good soup."

At dawn Christmas morning, instinct told me to turn over the butchering and cooking to a friend and take off with Nancy to spend Christmas alone in the bush. But curiosity kept me from retreating. I wanted to see what such a scrawny ox looked like on butchering, and if there *was* going to be a fight, I wanted to catch every word of it. Anthropologists are incurable that way.

The great beast was driven up to our dancing ground, and a shot in the forehead dropped it in its tracks.

Continued on page 60

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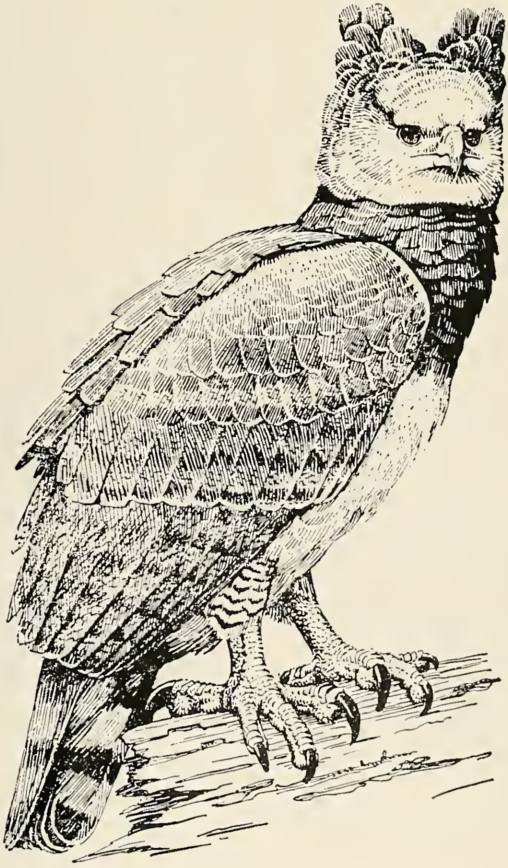

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A SOVIET PLAN

In a frank report, an eminent Russian geographer analyzes past mistakes and warns of greater potential dangers as the USSR exploits its natural resources

by Innokenti P. Gerasimov

photographs by Jerry Cooke

The transformation of nature in the Soviet Union has a purposeful and scientific character. The Soviet Union was the first country in the world to initiate government measures for transforming nature over extensive areas for the benefit of the national economy. These measures are included in general outline in the Program of the Communist Party of the Soviet Union. They constitute an important part of our economic plans and have repeatedly been given concrete shape in decisions of plenary meetings of the party's central committee. Universal interest has been aroused by the way in which the state has tackled major scientific problems connected with the natural environment. The tremendous importance of rationally exploiting and preserving natural resources is recognized everywhere.

Because of industrialization and the rapid growth and concentration of population in large urban centers, the deterioration of our natural environment (the biosphere) is proceeding throughout the world at an ever increasing pace. This results in developments that endanger the well-being of mankind—the pollution of the atmosphere and soil beyond all permissible limits with domestic and industrial refuse, a shortage of land and other natural resources owing to their irrational use, the irreparable destruction of natural ecosystems, and the complete extinction of many species of living organisms.

The ever increasing extent to which man is interfering with his natural environment makes it essential, in my view, to prepare a general scientific plan for the transformation of nature. In contrast to the capitalist countries, the USSR, with its planned socialist economy, should be able to exploit nature in a purposeful, rational manner.

The tremendous hydroengineering achievements of the Soviet Union, which have greatly increased its power potential and helped to bring about basic improvements in important waterways, are well known. The rapid development of the power industry has been made possible by redirecting the natural flow of rivers, mainly in the European parts of the country, in the basins of the Volga, Dnieper, and Don, and to some extent in the big rivers in Siberia and Central Asia.

However, these solutions to some important economic problems have led to serious consequences that were not anticipated. The full extent of these unforeseen consequences has not yet been revealed, but what is already known should undergo comprehensive scientific and economic analysis. This is necessary in the first place in order to forecast the impact of future hydroengineering schemes.

Some of the consequences of the big hydroengineering developments of past years were unavoidable. One result was the flooding, by artificially created reservoirs, of tracts of agricultural and forest land covering many millions of hectares (one hectare = 2.47 acres). Even larger areas have been subjected to indirect effects of the reservoirs—swamping, salinization, disintegration of banks, and soil erosion. These processes, which spoil the land in areas bordering on the reservoirs, are continuing, thus requiring urgent work on drainage, the strengthening of banks, and land improvement.

Under the influence of such reservoirs, the total water exchange in the hydrographic basins affected by the alteration of the flow has been greatly reduced. This reduces the capacity of many rivers to rid themselves of

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Academician Innokenti P. Gerasimov's proposals for a rational transformation of nature first appeared in the influential Soviet magazine Communist. *The* Soviet News *of London printed an English version, which has been slightly abridged for this article.*

FOR NATURE

the growing quantities of industrial and domestic waste, and a gradual pollution of the river occurs. As a consequence, the water supply problem, serious as it already was in many industrial regions, has been further worsened.

Urgent and complex engineering measures have had to be taken in order to control and process sewage and to make use of a closed water cycle. So far, these measures have failed to overcome all the water supply difficulties.

The regulation of the natural flow of rivers has increased the losses of moisture through evaporation from reservoirs. This is particularly great in the steppe and desert areas and has changed the subterranean water-feeding conditions through the infiltration of water from the rivers. All these changes have not yet been sufficiently investigated.

Far more obvious are the deleterious effects of hydroengineering developments on the fishing industry in practically all the internal basins. The resultant disturbance of the natural behavior of the rivers, their deltas and estuaries (especially in the case of the Volga, Dnieper, and Don basins), has led to very heavy losses in the fishing industry. Furthermore, various special engineering and economic measures—the building of fish-breeding farms, artificial fish hatcheries, and so on—have had to be taken to combat these effects.

Major new hydroelectric schemes are being planned in the Soviet Union. There can be no doubt that their implementation will bring about many changes, like those already described, in the natural environment of vast territories, but on an even larger scale. With accumulated experience to fall back on, it should be possible to anticipate some of the probable changes and to take measures to prevent or at least mitigate their harmful effects. This, however, is not enough for a complete and reliable forecast to be made of all the complex and interconnected natural phenomena that may arise and develop as a result of large-scale hydroengineering work.

A comprehensive account of all the economic gains and losses involved in a project must be part of the forecast. In addition to the direct building investments, the revenue to be derived from the electricity produced, and the increase in agricultural production (with the development of irrigation), the calculations must cover indirect investments and losses resulting from the disturbance of natural conditions and the measures required to forestall unfavorable changes in nature. In forecasts of this kind all natural resources must be given an economic, monetary assessment.

How important this is may be seen, for instance, from the physicogeographical analysis made of the natural phenomena of West Siberia and the forecast made of the changes likely to occur if the Lower Ob hydroelectric station is built. An analysis has shown how absolutely impermissible it would be to build even a low-pressure dam in the part of the Ob immediately above the delta. Any head of water created there, this forecast has revealed, would have a disastrous effect on the general water regimen of the West Siberian plain and would increase its boggy nature, which is already hampering the development of this territory.

On the other hand, regulating the flow of the Ob and the Irtysh, and their tributaries in the mountainous parts of their catchment areas, would have a beneficial effect on the water regimen of West Siberia.

Scientific forecasts of this kind must become an indispensable part of all design operations. In order to do this, it will clearly be necessary to go beyond the solution of purely hydroengineering problems.

Our total cultivated land amounts to 225 million hectares. Nearly three-quarters of this area is situated in arid areas and in steppe and forest-steppe zones, about one-tenth in desert, and only about a quarter in forested and adequately moist zones. As regards its natural conditions, therefore, agriculture in the USSR differs markedly from that of the United States and of many countries of western Europe, the difference being fundamentally to our disadvantage.

What I am referring to is the periodic, and in some cases systematic, shortage of moisture in the soils of the arid zones. This is largely why our average yields in areas without artificial irrigation are lower than in many countries with more favorable atmospheric moisture conditions.

An increase in the natural supply of moisture in cultivated soils, together with the development of artificial irrigation, will help to step up and stabilize crop yields in the Soviet Union. It also will produce the maximum results from the mechanization and chemicalization of agriculture, carried out jointly on a wide scale.

No less than two-thirds of the total cultivated land in the USSR, or nearly 150 million hectares, needs more moisture, while between 50 and 60 million hectares are subject to erosion. Yet despite the tremendous importance of the measures needed to create a favorable microclimate, increase the moisture content of the soil, and combat erosion in the arid zones, these measures are not yet being carried out on an adequate scale. Much could have been done in this connection at a minimum cost by the collective and state farms themselves.

In order to make our agriculture more productive, I believe it is necessary to draw up a general scientific plan of radical measures designed to improve the microclimate of territories, increase the natural moisture content of fields, and eliminate completely the destructive processes of erosion.

Important to the development of agriculture is the draining of boggy land and the irrigation of desert and arid land. Artificial irrigation sharply increases the biological productivity of land and makes agriculture more stable. But it demands the greatest care, and the fullest account needs to be taken of the specific conditions of the areas being irrigated. Underestimation of the importance of this leads to dire consequences.

The total irrigated area in the Soviet Union has increased greatly under the Soviet government, and now amounts to some 10 million hectares. This was achieved through the systematic engineering reconstruction of old irrigation systems and the irrigation of new areas in Central Asia, southern Kazakhstan, and Transcaucasia. This rapid expansion of irrigated farming has created new opportunities for agriculture in our southern republics.

However, the economic benefits of this extensive irrigation program have not been as great as they might have been because of secondary salinization of the irrigated soils. Secondary salinization has now spread to a substantial part of our irrigated land and has reduced crop yields. Moreover, it sometimes makes irrigated land unusable.

The local population, as a result of long experience, has developed methods of combating secondary salinization—periodically washing the salinated soils, extensively mixing them, and not cultivating them to excess. However, the engineering reconstruction of the irrigation systems carried out under the Soviet government requires that the land be cultivated much more intensively. As a result, there has been extensive secondary salinization of soils in many irrigated regions.

Age-old experience of irrigation farming, coupled with years of scientific research, now makes it possible to take into account all the basic factors in the development of secondary salinization and to work out a set of hydrotechnical and agricultural improvement measures capable of arresting and ultimately eradicating this process. However, these measures are only being applied to a fraction of the affected areas.

A special prognosis zoning of the entire irrigated (and boggy) territory of the country should recommend a water-and-salt regimen and determine methods and rates of watering and draining, which will insure the maximum fertility in the

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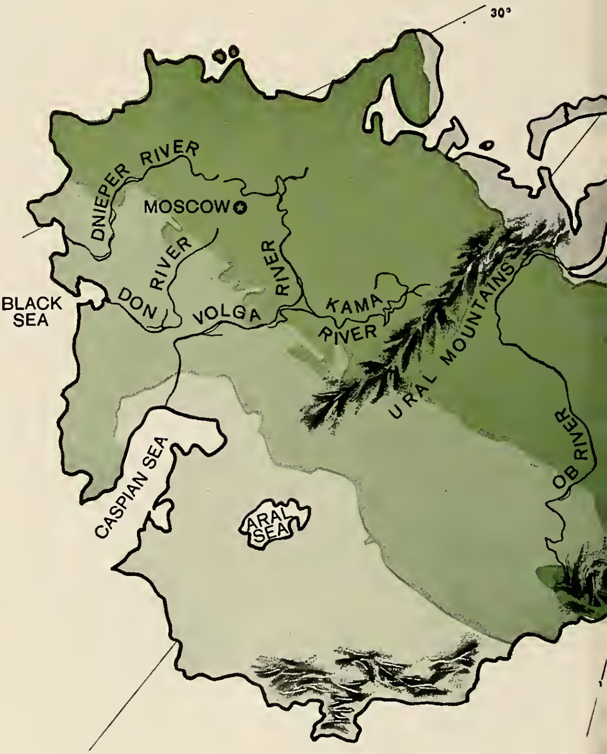

DESERT
STEPPE
FOREST
TUNDRA

irrigated territories, and either arrest or completely eliminate secondary salinization. The drawing up of these forecasts would be an important part of a general plan for the transformation of nature.

Soviet scientists have proposed and substantiated the principle of the extended reproduction of all renewable natural resources. This is aimed at fully meeting the economy's growing demands for these resources and at bringing about a simultaneous and steady increase in the resources and their quality.

For instance, an over-all survey of land resources has led to the conclusion that the best land in our forest-steppe and steppe zones, totaling 230 million hectares, has been exhausted or is nearing that state from the standpoint of agriculture. Along with steps to preserve and enhance the natural fertility of these areas, any further extension of the arable area must be accompanied by large-scale improvements to raise the natural fertility of the land being brought into cultivation.

A comprehensive register and assessment of all the country's land resources is needed as a basis for all practical measures in agriculture. Unfortunately, no such register exists yet, and the work of compiling one is proceeding far too slowly.

Another important economic problem is the rational utilization of natural fodder resources, based on their improvement and reproduction. The Soviet Union's pasture and grazing areas and areas suitable for haymaking total 700 million hectares. Half of this area is made up of tundra grazing land of low food value, suitable for deer. However, many other natural fodder regions in the USSR are also marked by low productivity, due to insufficient efforts to better them by land improvement (draining, watering, and clearing of scrub).

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CENTRAL ASIA

Our scientific institutions have put forward many valuable proposals for improving the productivity of natural pastures and grazing land. The rational use of the natural fodder resources would open promising prospects from the economic point of view. Estimates show that if the necessary measures were carried out in the desert grazing lands of Central Asia, some 25 to 30 million sheep could be kept there—many times more than the present figure.

We have in the USSR a vast forest area amounting to 800 million hectares—a forest area more than five times greater than the corresponding area in the whole of Europe and nearly double the size of that of Canada and the United States. We rank first in the world in timber felling.

With their immense annual increment, the impression might be gained that our forest resources are not yet being fully utilized. A more detailed examination, however, leads us to a completely different conclusion. Our forest resources are distributed very unevenly over the country. This is due not only to the diverse natural conditions (the absence of forests in the southern regions and arid areas) but also to various degrees of deforestation. In the USSR there is a thickly forested zone (the northeast of the European part and of the Urals, western and eastern Siberia), along with a medium-forested zone (the northwest, the northern Urals), and a sparsely forested zone (the center of the European part of the country). However, the timber organizations pay little attention to the geography of forest resources. As a result, more felling is done in the more accessible, though less densely forested, areas, while less takes place in the heavily forested regions. Consequently, the forests are decreasing where there is excessive felling, and the composition of forests is deteriorating.

The existing timber system—felling and regeneration—and also timber-dressing methods are in need of serious improvement.

The principle of the all-round utilization of forest resources, based on their extended reproduction, has been universally accepted in theory. It is a long way, however, from being applied in practice, and our forest resources continue to be depleted of their most valuable parts.

The history and character of the exploitation of wildlife in the USSR have provided a wealth of material on the extended reproduction of natural resources. During the Soviet period a great deal has been done to restore the numbers of valuable animals by temporary prohibitions and regulation of commercial hunting and trapping, and by the enrichment of the fauna with the introduction of new species, often with remarkable results. A case in point is the restoration of the beaver and sable populations and the breeding of muskrats, mink, and other fur-bearing animals.

Animal breeding has now become an important industry. Our nature reserves have made it possible for many rare species of animals to survive, while others (such as saiga and elk) have increased in numbers.

Despite the losses that hydroengineering schemes have inflicted on the fishing industry, numerous measures have been worked out and implemented to breed fish in artificial conditions and acclimatize them in various river basins. Gray mullet, for instance, have been taken from the Black Sea and successfully acclimatized in the Caspian and Aral Seas, where they are increasing in numbers. The Pacific salmon has been acclimatized in both the Barents and White Seas.

The question may legitimately be asked: What is it in our society, with its consistent progress in all spheres of life, that interferes with a rapid advance in such an extremely important field as the rational exploitation of nature? The answer is far from simple. We must begin by admitting that the erroneous idea that natural resources are inexhaustible has taken deep root, and that a dangerous tradition has developed whereby the gifts of nature are used in a feckless and uncontrolled way. And the answer must conclude by noting that our scientific knowledge has not yet reached a level at which it can insure faultless control by man over the extremely complicated natural processes existing in our environment. It is clear that the foundation for such rational control must be scientifically accurate forecasts of the transformations in nature that will follow from human intervention.

We have already referred to the preparation of new hydroengineering schemes. Many of these provide for fuller regulation of the flow of the biggest rivers by constructing huge dams and reservoirs, and by large-scale diversions of waters from one river basin to another. Diversions of this kind have long been considered necessary in the European territory of the USSR—from the basins of northern rivers and lakes to the southern river systems (the Kama, Volga, Dnieper, and Don basins). Apart from supplying water for industrial regions, this diversion would increase the flow of water into the Azov and Caspian Seas, improve conditions in the lower reaches of the Volga and the Don, and facilitate the irrigation and watering of arid land and grazing areas in the southeast.

For a long time it has been proposed that part of the waters of Siberian rivers should be diverted to Kazakhstan and Central Asia, both to maintain the water balance of the Aral Sea and to promote irrigation schemes in the Central Asian plains.

The scientific and technical plans drawn up by our hydroengineering experts must, apart from the necessary technical estimates and designs, be based upon complex scientific forecasts of the long-term influence on the natural environment.

Take, for example, the problem of the regulation of river waters in the European territory of the USSR and the diversion of part of the waters from the northern basins to the south. Work on this problem must start with estimates of the probable changes in the water balance of those river systems and lake basins from which, and to which, the water is to be diverted.

Next, the various channels that will divert the waters and the technical requirements for making those channels will have to be studied.

A field of sunflowe
basks in the warm su
of the Russian stepp
in the Ukrain
The seeds are an importa
farm crop in regio
of light rainfal

In the distance a plow turns
over the rich black earth
of the plains in the
Siberian region of
the Soviet Union.
Nearly three-quarters of
the country's tilled
land is in areas of
deficient precipitation.

The distant snow-covered mountains are a bountiful source of water for the lowlands of Samarkand in south central Russia. However, the underground flow and evaporation of mountain water may be leading factors in the harmful salinization of irrigated land.

Birch forests northwest of the Urals are part of a vast forest belt that extends across the USSR. Near the east-European cities some forests have been destructively depleted.

A horse pulls a lone passenger in an old cart along a new road in a Siberian forest. Access to the Siberian forests has helped Russia maintain its lead in world timber production.

Forecasts of all changes in the water regimen of the river systems and lake basins involved, and also the flooding of adjacent areas, must be worked out at the same time. On the basis of these forecasts the various technical, land improvement, and economic problems will have to be solved, and measures taken to mitigate or eliminate the adverse effects of hydroengineering projects on the natural conditions.

All this, however, is only the first stage in a scientific approach to the problem. Since transformation of the flow of rivers on a very large scale is involved. the impact on the entire water exchange of the Russian Plain will be great. It will affect not only the water regimen and balance of many rivers and lakes but also the feeding conditions and the resources of ground and subterranean waters, including artesian wells.

It will also be important to forecast the amounts of heat and fresh water that will be lost by the White and Pechora Seas. the Gulf of Finland, and the Gulf of Riga, and the way in which these losses will affect the heat and ice regimen and the biological productivity of the sea basins.

The next stage will require an even higher standard of prognostication, connected with the analysis of the general geographical conditions involved in the formation of the water balance in the European part of the USSR. In the relatively recent past, practically all of the northern half of the Russian Plain was densely wooded, while its southern half was in the process of being slowly and unevenly brought into cultivation. Over the past 100 to 150 years the forests have been so intensively cut down in the center and northwest that little of them now remains, while the steppe area has been completely ploughed up. A new system of moisture circulation with a rapid and extensive runoff has been established.

Twenty years ago a start was made under state auspices on planting protective woods and forest shelter belts in the steppe and forest-steppe regions, together with the application of other methods for the retention of the surface flow. Later, large-scale drainage, afforestation. and other measures were taken.

All this could not fail to have a profound effect on the general circulation of moisture in the Russian Plain. The forecasts made under the new conditions of moisture circulation may enable us to adopt a completely new approach to the problem of determining the regimen and balance of the artificial reservoirs and to take a new look at the demands of irrigation and the possibilities of utilizing underground waters. Such a far-reaching prognosis could help us revise the entire system of water-economy estimates now in use. as well as the hydroengineering construction schemes.

Another recent, acute problem is the future of the Aral Sea. Ever increasing use of the waters of the Amu Darya and Syr Darya for irrigation purposes is already lowering the level of the Aral Sea and changing its characteristics. This process is bound to be further accentuated. But the problem we are examining is even broader. It consists in this case of the transformation of the entire moisture circulation between the mountainous part of Central Asia and its desert plains.

Special investigations must be made of the extent to which this general moisture circulation is self-contained and of the possibilities for its intensification—through artificial regulation of glaciers. interception of rainfall and snowfall in the mountains. and an increase of evaporation in newly irrigated areas and subsequent transfer and accumulation of moisture in the mountain ranges.

The role of the underground flow of mountain waters must also be cleared up. Perhaps it is precisely the extensive evaporation of this underground flow that serves as one of the main factors leading to the accumulation of salts in the soils of irrigated oases in Central Asia. Thus. the problem of the transformation of nature in Central Asia and south Kazakhstan by full use of the river waters for irrigation purposes should now be subjected to a new and comprehensive analysis.

In eastern Siberia work has started on the world's largest hydroelectric station. This involves the construction of dams across the Yenisei, the Angara, the Lena, the Vilyui, and other rivers. These schemes are encouraged not only by the technical and economic conditions but also by many of the specific natural conditions of these territories.

The need arises, however, for a scientific forecast of the general effect this hydroengineering project will have on the natural conditions of the regions adjacent to the rivers and the Arctic seas, for Siberia's mighty rivers exercise a great influence on the permafrost regimen of their valleys. And while the total share of this flow, as compared with other sources of replenishment of the ocean waters, is quite small, its role in the ice regimen of all the large ocean gulfs along the northern shores of the Arctic is great.

Consequently, the people engaged in designing huge hydroelectric stations on the big Siberian rivers should carefully weigh all the possible climatic effects, as well as the effects on the rivers themselves, the catchment areas, and the seas washing the northern shores. All this could affect not only the forestry and fishing industries in these areas but also the future of the Northern Sea Route, which has been developed at the cost of such heroic efforts.

In present-day conditions the preservation of nature is inseparable from its transformation and from the rational use of its resources.

To preserve nature in an undisturbed or slightly altered state, a territory must be declared a reserve in which no economic activities are permitted. The creation of a system of reserves in the Soviet Union was initiated by Lenin's decree on "The Protection of Nature," issued in 1921. Today there are more than 80 reserves in the USSR with a total area of 6,400,000 hectares. Since their establishment they have accomplished a great deal in the study and preservation of nature. They have helped not only to preserve typical tracts in their primary state but also to save many species of animals that were on the verge of extinction.

The importance of the reserves is growing. They can and must be regarded primarily as unique sanctuaries of a vast collection of natural genetic materials (genetic stock of plants and animals) that nature has created over many hundreds of millions of years. These genetic stocks could not have been preserved in the form of the dead and dried-up materials of botanical herbariums or the zoological collections in museums. They had to be "conserved" alive within the natural, primitive communities in which they had developed. Only in this condition do they constitute invaluable material that can be used for directed selection and hybridization. It is easy to imagine the boundless possibilities for such biological "constructions" if we remember that the basic (species) composition of plants and animals introduced into agriculture is very limited and has not been extended to any appreciable extent for a long time. We should also note the recent productive "explosion" in the formation of cultivated plants on the basis of hybridization between different species.

It is not only in the genotypes of plants and animals that nature is rich. Over the long period of its geologic evolution it has created an endless variety of complex natural systems and processes with truly amazing capacities for adaptation to their environment. Today, therefore, the nature reserves are absolutely indispensable bridgeheads for comprehensive scientific investigations aimed at the purposeful transformation of nature.

A comparative study of the phenomena taking place in the primary natural environment and the modification of those phenomena by economic activity (in agriculture and forestry, for instance) will make possible an analysis of the effects of human activities upon the natural environment. The laws derived from this research can and should be widely used to work out ways and means for secondary purposeful exploitation of nature.

The scientific work on our nature reserves, as it is conducted, does not meet today's requirements. Research should be carried out in a unified program, and the leading nature reserves, at least, should be placed at the disposal of major research institutes.

The preservation of the natural environment and its purposeful improvement is of great importance in meeting cultural, human requirements. An acute and pressing problem in modern society is the provision of recreation in natural conditions for the urban population. This problem has until recently been confined to the establishment or expansion of health zones and resorts. Today, however, the creation of recreational facilities for the urban population outside the places where they permanently reside, calls for specially organized areas combining the original natural conditions, or such conditions artificially modified, with buildings and facilities to accommodate large numbers of visitors.

Thus the problem of making effective use of the natural environment for rest and recreation is becoming a new branch of scientific investigation, as well as an important part of the economy.

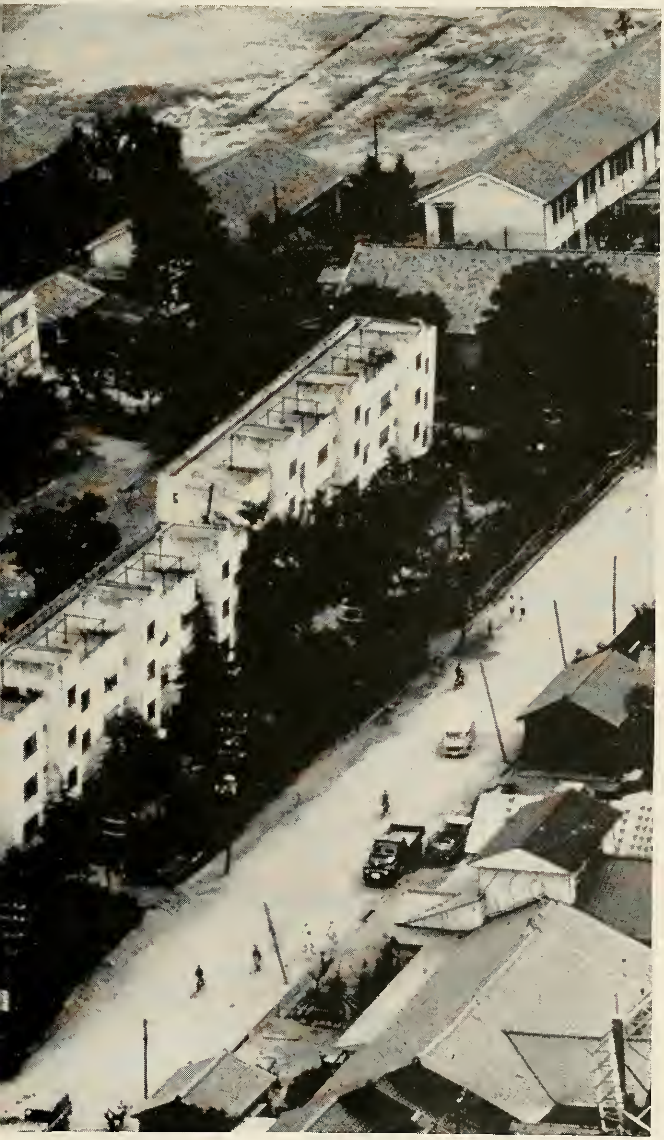
The practical implementation of the proposals in a general plan for the transformation of nature in the Soviet Union confronts Soviet geographers with new and important problems. In order to solve these problems successfully scientists must be given extensive and systematic assistance—their work must be incorporated in the state plan for scientific research, and they must be provided with the necessary personnel and funds.

Skiers pursue a favorite national pastime in a mountain park northeast of Alma Ata. Outdoor recreation is an expanding part of the economy of the Soviet Union.

EARTHQUAKES

by Charles F. Richter

A straining earth writes its own story in cracks and tremors

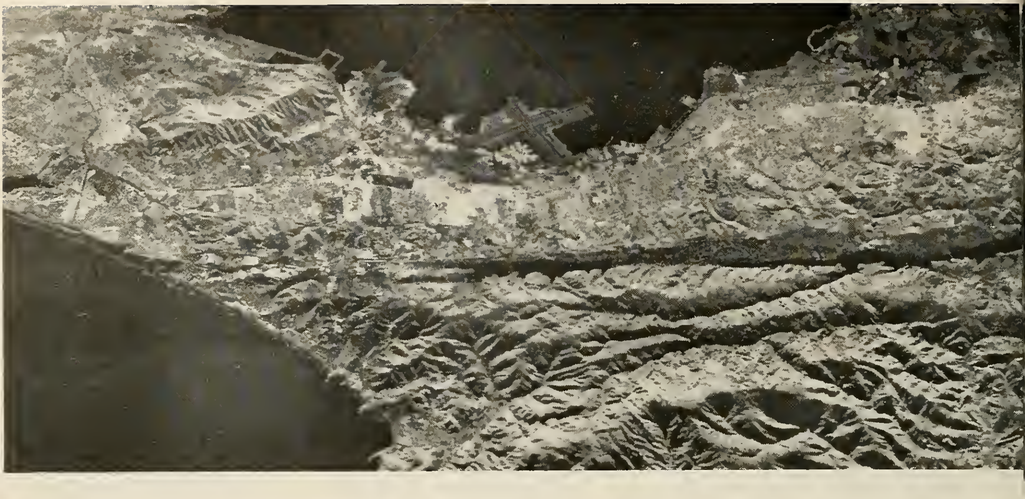


Buildings overturned by 1964 earthquake, Niigata, Japan.

Earthquakes, pestilence, famine. From time immemorial these were thought to be direct manifestations of the displeasure of offended powers, while eclipses and comets were regarded as their terrible precursors. But with the growth of urban civilization and the improvement of communications, such superstitions are gradually disappearing. No one now can logically maintain that an eclipse is inflicted as a punishment or a warning. Even small children learn that eclipses can be forecast centuries in advance. And with the night sky flooded by stray light, even comets no longer impress city dwellers.

Famine we tend to think of as afflicting only remote and backward populations, although in this we may someday be rudely disillusioned. Toward pestilence we also take a rather complacent attitude, despite the warnings of epidemiologists who strive vainly to remind us that great plagues are not altogether a thing of the past—witness the influenza epidemic during World War I.

Only earthquakes remain largely misunderstood, the object of unreasoning fear. A sudden catastrophe, with tens, even hundreds, of thousands of lives lost in a single event, naturally excites the apprehensive imagination. Panic feeds on ignorance, and few people realize that such losses are almost wholly preventable: that they result mainly from the collapse of unsound structures. The onset of earthquakes without warning leads the public, news media, and government officials to grasp eagerly at any hint of prediction, although really useful forecasting of earthquakes is still remote. Some scientists do not hesitate to encourage hope in earthquake prediction, while astrologers and sooth-



sayers are all too ready to name the time and place of a catastrophe.

As a veteran seismologist, I regret this pervasive emphasis on prediction. It directs attention away from the known risks, and the known measures that could be taken to remove them, and fixes it instead on vague, distant hopes. In a very real sense, we can already predict earthquakes well enough for practical purposes. We know where the danger areas are and which structures in those areas are unsafe and should be removed or rebuilt. Of course, it is easier, and cheaper, to talk about earthquake prediction.

What are earthquakes, and what do we know about them? Throughout the history of the earth, great forces have elevated and depressed continents, and folded and broken its surface into mountain chains and oceanic troughs. The ultimate source of these forces has long been discussed; perhaps in the "new global tectonics," to be briefly touched on later, we may glimpse these causes. Let us look first at their known effects.

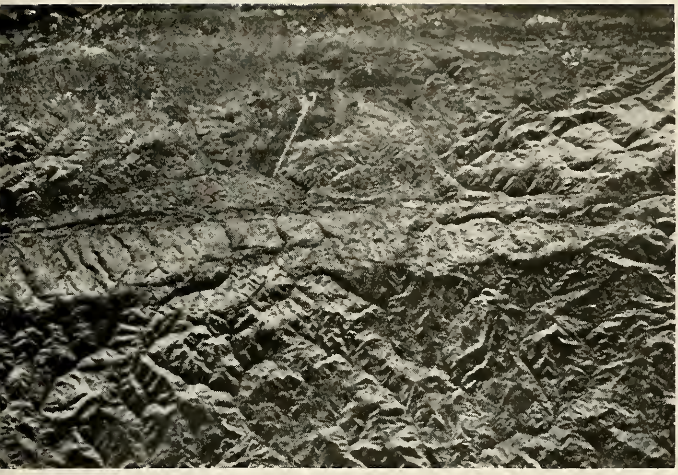
The typical large earthquake starts with fracturing within the earth, where the rocks are subjected to increasing strain until they break. The sudden fracturing is violent enough to vibrate the surrounding solid rocks as if they were jelly. These vibrations, called seismic waves, pass through the earth like waves through water; they compress and expand material in their path or shift it from side to side. Seismic waves travel over the whole surface of the earth and penetrate to its very center.

In many important earthquakes fracturing extends to the surface, where it follows established lines of weakness. These lines, the active geologic faults, are old wounds in the earth that have opened again and again. After an earthquake we may find that one side of a fault has been raised relative to the other, from a few inches up to ten feet or more (forty-seven feet in Alaska, 1899). Or the relative shift may be lateral, along a fault (fifteen to twenty feet in California, 1906 and 1940).

The parts played by the fracturing and the resultant seismic waves are very different. Fracturing reaches the surface along a belt usually only a few yards wide. Any structures extending across this belt are torn apart irresistibly. Since few such fault breaks in the past have cut across cities, there are not many instances of houses or other buildings wrecked in such a way. However, serious and expensive damage has resulted repeatedly to communication and transportation facilities. Highway and railroad bridges have been destroyed. Roads have been interrupted by vertical and horizontal offsets. In the 1952 earthquake in Kern County, California, six tunnels on the major railway route through Tehachapi Pass were put out of service by faulting. In 1940 fault damage to the canal system in the Imperial Valley deprived the western part of the valley of irrigation water, resulting in heavy crop losses and expensive reconstruction. In central California in 1906, the main water line supplying San Francisco was effectively shut off because it followed and crossed the San Andreas Fault several times.

Although heavy losses may be due directly to fault movement, most of the property damage and loss of life in earthquakes are caused by seismic waves shaking the ground. The waves originate at the fault but spread out from it with such intensity that serious damage may result one or two hundred miles away. In 1957 and 1962 there was heavy damage at Mexico City due to earthquakes that originated near the Pacific Coast, more than 150 miles away. The spectacular damage at and near Anchorage, Alaska, in 1964, occurred more than forty miles from the active fault.

While the degree of shaking tends to fall off with distance from the center of disturbance, it varies greatly depending on the solidity of the ground on which structures stand.

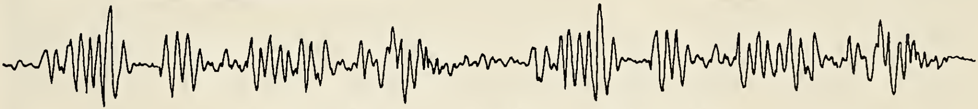


Aerial radar map shows San Andreas Fault cutting through central California. San Francisco Bay is at top left. The straight white line, at right center, is the two-mile linear accelerator of Stanford University.

One might suppose that soft and unconsolidated material would serve as a cushion to moderate the effects of shaking. This is true only to a limited extent; other, more important factors are at work, and centuries of observation have shown that generally the reverse is true. Other circumstances being equal, the intensity of shaking and, consequently, the destructive effects are much greater on alluvium, beach sands, artificial fill, or other unconsolidated foundation than they are on firm rock. The Biblical contrast between the experiences of the man who built his house on a rock and the one who set his on the sand still holds true. The severe effects in Mexico City developed because the city was built on the unstable ground of an ancient lake bed. The damage at Anchorage resulted largely from slides touched off by shaking in very unstable terrace material.

Our detailed knowledge of ground shaking during an earthquake depends almost wholly on the records written by seismographs. Modern seismology without the seismograph would be as unthinkable as modern astronomy without the telescope: but whereas the telescope has been in use for more than three centuries. the true seismograph dates only from about 1880.

Workers in the field had been trying to develop instrumentation since seismology became an organized science in the 1850's. Nearly thirty years later John Milne and a group of British scientists working in



THE RICHTER SCALE: RATING EARTHQUAKES

Today no news story about an earthquake is complete without mention of its magnitude on the Richter scale; the public has become familiar with the name of the author of this article. Richter decided thirty-five years ago to devise a magnitude scale with the public in mind; he wanted to prevent misunderstanding of earthquake statistics.

The scale, Richter recalls, grew out of an emergency: he and his colleagues were about to publish lists showing that southern California was then experiencing more than two hundred earthquakes annually, and they wanted to avoid starting a panic. This meant they had to be able to distinguish between large and small earthquakes; they could not use local effects as the criteria because many earthquakes were centered in unpopulated areas. It seemed ideal to devise some way of making measurements directly on seismograms.

After a couple of false starts, Richter adapted an idea first used by K. Wadati in Japan. He plotted the maximum deflection recorded on the seismogram against the distance from the instrument to the epicenter. The range of deflections proved too great until he accepted the suggestion of his colleague. Beno Gutenberg, that he use a logarithmic scale for the deflections while leaving the distance plot on a linear scale. When H. O. Wood urged that the newly defined quantity be given a distinctive name, Richter reached into his amateur astronomical background for the term magnitude.

Later he and Gutenberg adapted the scale so it could be used to rate large earthquakes occurring and recorded anywhere in the world. Gutenberg also worked out applications for deep-focus earthquakes.

Today seismologists use several magnitude scales, depending on the type of earthquake and type of data available. The name "Richter scale" applies strictly only to the first, but in practice it is used for all of them.

Japan designed and built the first apparatus that reliably detected and recorded earthquakes.

Seismographs, like other precision instruments, involve many technical details. However, the fundamental principle can be simply stated because it depends merely on one of Newton's laws of motion, that of inertia: every body remains in a state of rest or uniform motion unless acted upon by an outside force. If a heavy body is suspended so that it is free to move relative to its supporting frame—which is fixed to the ground—then, when the earth itself moves, the heavy mass, tending to remain in place, will appear to be in motion relative to the frame. In the seismograph a magnifying, or amplifying, system is attached to the inertial mass to increase the small motions. Originally mechanical lever magnification was used, then optical systems were applied, while in recent years electromagnetic and electronic amplifications have been employed, thus multiplying the motions of the inertial mass by as much as 100,000. A third and final element of the instrument is the recording drum. This is nothing but a rotating drum like those used to record continuous records of temperature and pressure at weather stations. It carries sensitized paper—now usually photographic—so that the seismogram is written by a focused spot of light, and the whole is enclosed in a dark room. Early seismographs often used a sharp point, or stylus, to write on smoked paper; this was the origin of the seismograph "needle," which still appears in newspaper headlines.

The first important result of the seismograph was the complexity of the earth motion recorded. Oscillations were found to take place vertically and in all horizontal directions, with rapidly changing amplitudes and periods. For engineers this meant that to design against earthquakes would require provision, not against specific, well-defined types of vibration, but against a wide range of motions.

Actual ground motions are small, even in moderately strong shaking. An earthquake intense enough locally to damage ordinary structures may produce motions with a range of only 4/1000 of an inch or less; but the motions are very rapid, ten to twenty times a second, and the accelerations are about one-tenth that of gravity. This implies that structures are being subjected to internal forces of about one-tenth their weight. "One-tenth of gravity" is a standard rule of thumb in design against earthquakes but it is far from perfect. Structures planned without greater precision may develop trouble or even fail in special circumstances; yet it is far better than no earthquake provision at all.

The critical factor is the horizontal part of earthquake shaking. Any building erected according to common practice will stand up against vertical loading, even overloading, and consequently has some resistance to up-and-down shaking; but common practice almost never provides any resistance to lateral forces and lateral distortion, so that walls that have stood up under work and weather for many years may topple in a moderate earthquake.

The next important result was unexpected, but it dominated the development of seismology for many years—the registration of teleseisms, earthquakes originating at great distances from the recording station. The discovery was made by E. von Rebeur-Paschwitz, working in Germany with magnetometers. He found that his instruments were occasionally disturbed by long, slow oscillations, which he suspected might be due to distant large earthquakes. Confirmation came on April 18, 1889, when such a disturbance was recorded at Potsdam at the hour of a considerable earthquake in Japan. This was an event in seismology comparable, in astronomy, to that night in 1609 when Galileo first directed his telescope to the sky.

Milne, returning to England from Japan, distributed seismographs over the then far-flung territory of the British Empire. Bringing together the recordings of all these stations, he was able to make the first valid study of the geographical distribution of large earthquakes.

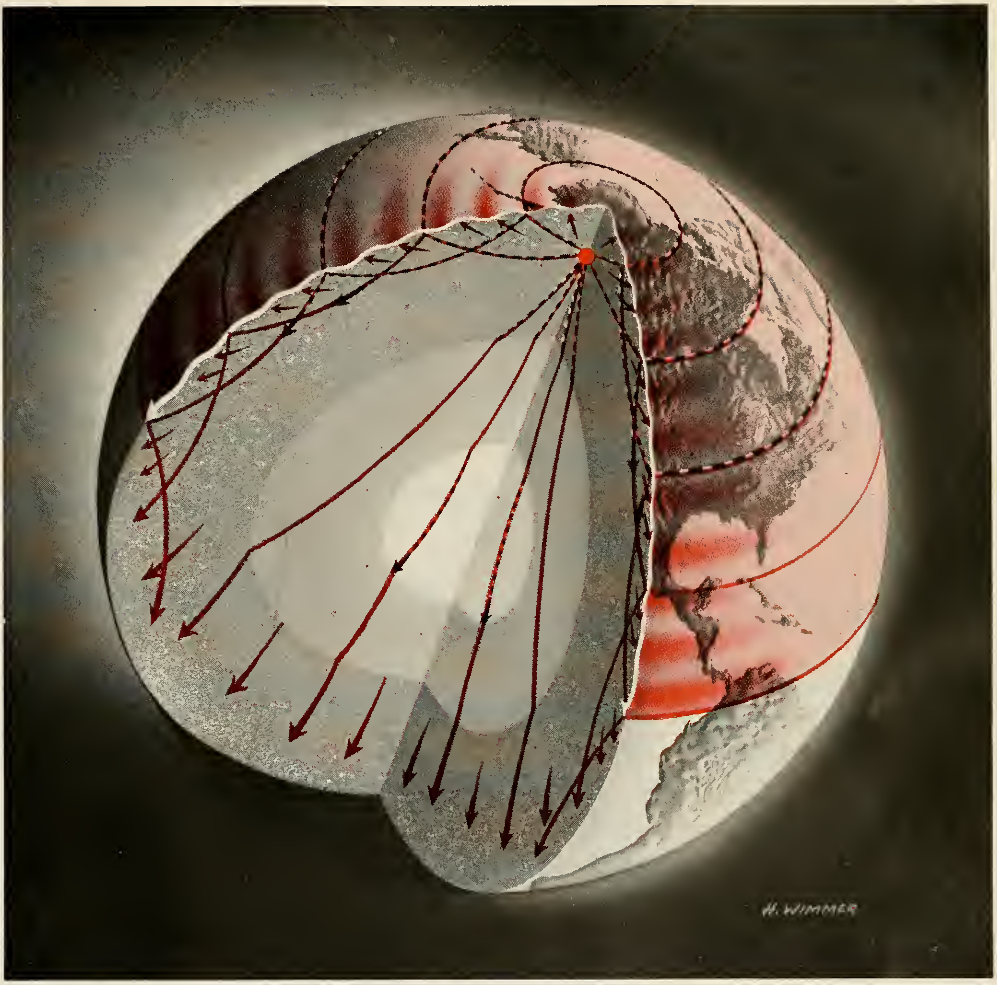
Emil Wiechert in Germany, Prince Galitzin of Imperial Russia, and Milne in England were the three outstanding figures in seismology at the turn of the century. Milne's seismographs were little better than earthquake detectors and tended to distort the actual motions. Wiechert and Galitzin constructed instruments that were designed to give a truer representation; they and others published extensively on the mathematical theory required to interpret the new recordings.

Improved instruments resolved the former confusing tangle recorded by the seismograph into a classifiable succession of vibrations produced by different kinds of seismic waves passing through the ground. It was observed that the conspicuous, large swinging motions that constituted most of the record as written by early seismographs were regularly preceded by a smaller motion, termed the "preliminary tremor." This motion was usually subdivisible into a first and second preliminary tremor, abbreviated to P and S from the initials of the Latin words *primae* and *secundae*. (Current authors tend to write "primary" and "secondary" for P and S, thereby confusing both the student and the ordinary reader.) The beginning of the group of large waves was designated L, the initial of "long," for by comparison with P and S, these waves are long and slow.

The L waves are surface waves; they travel from the earthquake's source around the surface of the earth to the recording station. Indeed, they go on for great distances, and in recording great earthquakes it is not unusual to detect such waves on the fourth or fifth time around.

P and S waves, on the other hand, travel through the body of the earth; P waves can even pass directly

Seismic waves travel around and through the earth following a hypothetical earthquake in Alaska. P waves, the fastest, are in red. S waves, half as fast, are red and black. L waves, white, move along the surface. Seismologists have some evidence that S waves form when P waves penetrate the solid inner core of the earth.



through its center. This discovery opened a whole new field of exploration: with P waves we "see" into the interior of the earth and investigate its structure in detail. For this large area of research the designation "geonomy" is increasingly in use. In addition to earthquake data, geonomy uses observations of the earth's magnetic and gravitational fields and laboratory experiments on rocks under pressure.

A major conclusion of geonomists is that the earth has a central core, the outer portion of which is liquid. In 1913, using teleseismic recordings Beno Gutenberg, then at Göttingen, found the top of the core to be 1,850 miles below the surface of the earth. This distance is less than halfway to the center, so the core is a body of considerable size, somewhat larger than the planet Mars.

In 1937 Inge Lehmann of Copenhagen pointed out that seismograms indicate a further subdivision within the core. The smaller inner core begins at a depth of about 3,100 miles, so its radius is only 900 miles. There is reason to believe that its material may again be solid; theoretically, it should be possible to confirm this from seismograms, but the necessary observations are difficult, and no one has yet obtained definite results.

The main body of the earth outside the core is termed the mantle, except for the relatively thin crust that overlies it. The mantle is solid, but the crust contains local spots of melting, chiefly in volcanic regions.

Evidence for liquid and solid character comes from the behavior of P and S waves. Physically, P waves are of the same nature as sound waves, but generally their vibrations are slower than those that can be heard. Most P-wave energy occurs in the frequency range from 1 to 20 cycles per second, while audible sounds range from 60 cycles per second upward. Occasionally, enough of the earthquake energy gets into the acoustic frequency range to produce an audible earthquake sound, usually a deep rumble.

S waves are sound waves or not, according to your preference. They can never be heard. Whereas P waves and ordinary sound waves cause compression and expansion in the direction they are traveling, S waves set the rock particles vibrating at right angles to the path of the waves. S waves can exist only in a solid medium, not in a liquid or in air, and we find that they are stopped at the surface of the core.

The overlying crust is separated from the mantle by the Mohorovičič discontinuity, so called for its discover, Anton Mohorovičič of Zagreb, who identified it using seismographic evidence derived from a destructive earthquake in Croatia in 1909. Understandably, it has come to be referred to as "the Moho." Under the continents, it is found at depths varying from about fifteen to about forty miles; beneath the oceans it is usually about seven miles below sea level. Under the deepest troughs, this would mean that the crust is only a few miles thick.

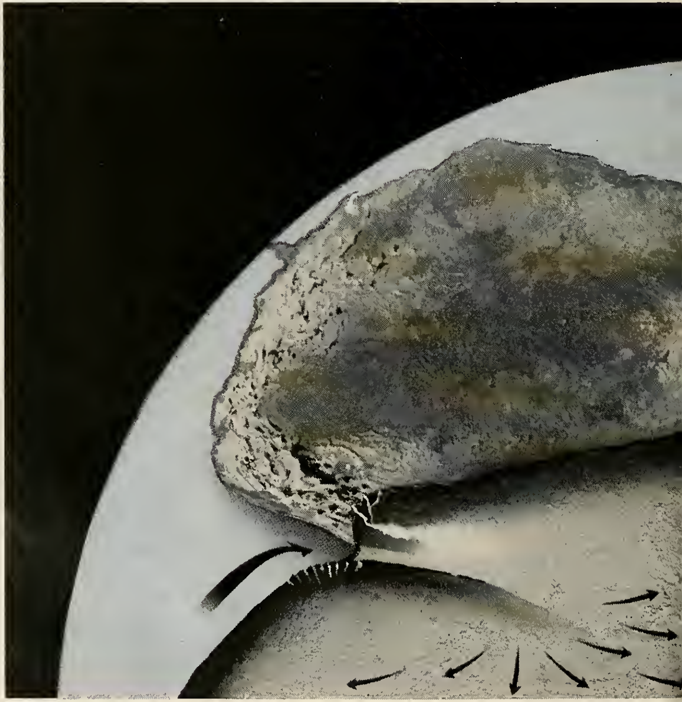
The great majority of earthquakes originate within the crust, but there is an important and interesting group that occurs in the mantle at depths down to 450 miles. None have been observed below this depth. These deep-focus earthquakes are geographically very restricted; those deeper than 180 miles are generally confined to the circum-Pacific belt.

Milne was the first to show that most earthquakes are centered in the oceans, generally not far from continental coasts. About 80 percent of the earthquake activity of the world occurs at the margins of the Pacific Ocean; most of the rest takes place in a second belt, extending from Mediterranean Europe across Asia, with a branch passing through the East Indies.

In the last few years new importance has been attached to those earthquakes—almost never large, but sometimes numerous—that occur outside the main belts, along the ridge structures traversing almost all the oceans. The centers of these oceanic ridges are zones of fracturing and rifting, which join to form a worldwide rift system. In what has been styled the "new global tectonics," such rifts play a major role. According to these theories, material welling up through the mantle forms the ridges; then it spreads outward, carrying the overlaying oceanic crust with it. In the Pacific, as this spreading sea floor approaches surrounding island or mountain arcs, such as the Aleutian Islands, Japan, the Tonga Islands, or western South America, the crust plunges downward at an angle of about 45 degrees, the descending crustal slab is fractured internally, and deep-focus earthquakes result.

Here we conclude our general picture of the nature of earthquakes, and return to problems of risk. Planning against earthquakes is furthered by the construction of a regionalization map, often called a risk map. From the known history of earthquakes (including seismograph registrations of recent years) plus geologic evidence (including

A cross section through the Southern Hemisphere provides a simplified picture of global tectonics. Mantle material wells up along the mid-Atlantic ridge system at right. Its lateral movement drags the crust and spreads South America and Africa farther apart. At left, an eastward-moving section of mantle dips beneath the western coast of America, carrying crust down to create a deep trench. This coast is the site of frequent earthquakes.

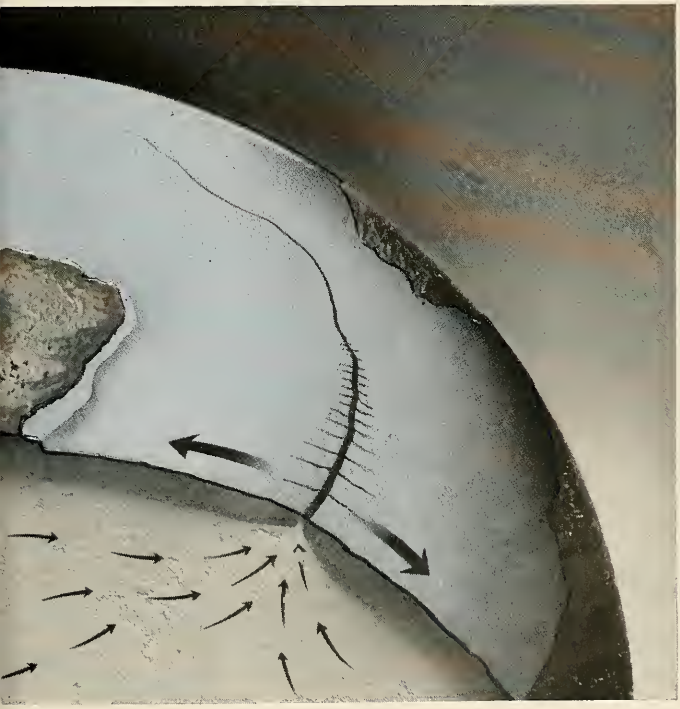


the identification of known active faults), one can make a map showing the maximum degree of expectable shaking in different zones, but it will not indicate how often such shaking may occur. The latest map of this kind for the United States (*adaptation, page 45*) was issued by the U.S. Coast and Geodetic Survey in 1969. Heavy shading in the central Mississippi Valley is a reminder of great earthquakes in that area in 1811 and 1812: for all we know, another may happen at any time. Smaller ones are not infrequent there; one on November 9, 1968, was felt in twenty states.

For all estimates of risk we must make proper use of earthquake statistics and apply sound critical judgment to the haphazard information that accidents of history have handed down to us. A magnitude scale was originally set up to obviate common and serious errors in such use. The particular numerical magnitude scale is less important than the idea of magnitude itself, and its distinction from intensity.

Intensity, as a technical term in seismology, indicates the degree of local shaking at a given point of observation. In any one earthquake, intensity ordinarily will be highest in a limited area and will fall off as distance increases from that center. At a particular locality, a small earthquake originating nearby may result in stronger shaking and, hence, higher intensity than a large earthquake far away. Magnitude, on the other hand, is intended as a number characteristic of the earthquake as a whole and should be the same no matter what observations are used to determine it.

Intensity does not represent a measurement: it is a rating by a practiced observer, based on an arbitrary scale in which the grades progress upward from barely noticeable shaking through various levels of damage to that of general destruction. The effects on buildings and other works of construction provide most of the evidence; however, ground disturbances in the form of cracking, sliding, and so on, are also considered. To discourage use of intensity ratings as if they represented measurement, Roman numerals are employed. The scale most generally used now is the modified Mercalli scale; its most recent form is often called "the international scale." (Press reports sometimes confuse it with the better-known magnitude scale.) The Mercalli scale has grades from I to XII; the effects at each level are standardized and described in much detail.



So much for intensity, which is the older technical term: now let us look at the newer term, magnitude. This does not supplant the use of intensity, but supplements and tends to refine it.

The word magnitude was borrowed, without asking permission, from the astronomers, who use it in a slightly different manner. Seismograms for different earthquakes, as recorded at a given recording station, differ conspicuously in the registered amplitudes, that is, the deflections of the recording point from its undisturbed position. A small or distant event may appear as a barely measurable irregularity of the recording line, while a large earthquake may fling the writing point completely off the edge of the sheet. For any one earthquake, recorded at a number of stations, the disturbance tends to fall off rapidly with distance from the epicenter. (Here we need the customary definition: Epicenter is a point on the earth's surface, taken to be directly above the locality in the depths where the earthquake event begins as the rocks start to break. The deep point of origin itself is termed the hypocenter, or at times, the focus.)

At twenty-five miles from the epicenter, the earth disturbance often has fallen off to about 10 percent. Hence, in using instrumental recordings to compare earthquakes, one must allow for differences in distance from the recording stations to the epicenters. The magnitude scale consists essentially of a tabulation, giving the relation between distance and recorded amplitude. Naturally, this relation is imperfect: earthquakes differ greatly, while the magnitude scale implicitly assumes that the only distinction between them is in the multiplying scale factor. The procedure is logarithmic, based on the equation

$$M_1 - M_2 = \log A_1 - \log A_2$$

where M_1 and M_2 are the magnitudes of two earthquakes, while A_1 and A_2 are the largest deflections (amplitudes) registered by the same seismograph, or by identically constructed seismographs at equal distances from the two epicenters.

As a concrete example, take two California earthquakes: the Long Beach disaster of 1933 and the great San Francisco event of 1906. Their magnitudes were approximately 6.3 and 8.3, respectively. The difference of 2.0 in the magnitudes implies that the 1906 earthquake wrote records 100 times as large as that of 1933 under comparable conditions (because 2.0 is the logarithm of 100). This ratio is not an estimate, not even a calculation; it expresses observed fact based on measurement of seismograms, particularly in Europe and Japan where both events were recorded by the same instruments.

The magnitude scale is often said to be a measure of the total energy released in an earthquake. This is not part of the definition, which is related with strict objectivity to the actual deflections of seismographs. Physically, especially for large earthquakes, magnitude corresponds more nearly to the rate of energy release, that is, to power, measured in kilowatts or horsepower.

Considering the crudeness of the implied assumptions, it is remarkable that the magnitude scale works as well as it does. Magnitudes are determined from the recordings at a number of stations, often with an accuracy of about half a unit; discussion often revolves around differences of two- or three-tenths. The explanation lies in the truly enormous range in earthquakes. We record events assigned to magnitudes from less than 1 to over 8, which implies a range of over 10 million to 1 in the ground motion produced at distant points.

Earthquakes of magnitude 1 ordinarily are detected only by sensitive seismographs. Those of magnitude 2 are perceptible to persons near the epicenter under favorable circumstances. Damage (intensity VI or VII) rarely appears in earthquakes of less than magnitude 4.5. These are not definitions, but observed facts. For convenience, seismologists speak of earthquakes of magnitude 7 and over as major earthquakes, while those of magnitude 8 and over are evidently great earthquakes.

From 1900 to 1964 there was a yearly average, the world over, of about twenty major earthquakes, one or two of which were usually great. Since 1964, the year of the great Alaskan earthquake, the annual total of major earthquakes has been distinctly less, and to the time of this writing, none exceeding magnitude 8 has occurred.

In southern California alone, in an average year there are about three hundred earthquakes of magnitude 3 or over; most of them center in remote areas and pass almost unnoticed. For the whole world, a million earthquakes a year is a conservative estimate because it certainly does not cover all those of the very smallest magnitudes.

One notices with some amusement that certain religious groups have picked this rather unfortunate time to insist that the number of earthquakes is increasing. In part they are misled by the increasing number of small earthquakes that are being cataloged and listed by newer, more sensitive stations throughout the world. It is worth remarking that the number of great earthquakes from 1896 to 1906 (about twenty-five) was greater than in any ten-year interval since.

Apparently this religious concern is associated with some of the words of the Gospels referring to the last days: "and there shall be famines and pestilences and earthquakes, in divers places." Assuredly, no safer forecast was ever made. One of the evangelists, or perhaps a copyist, added emphasis by reading "great earthquakes"; that still impresses a seismologist as not much of a prediction.

Three somewhat unrelated matters remain to be touched upon: seismic sea waves, tall modern buildings, and the latest scientific efforts toward prediction.

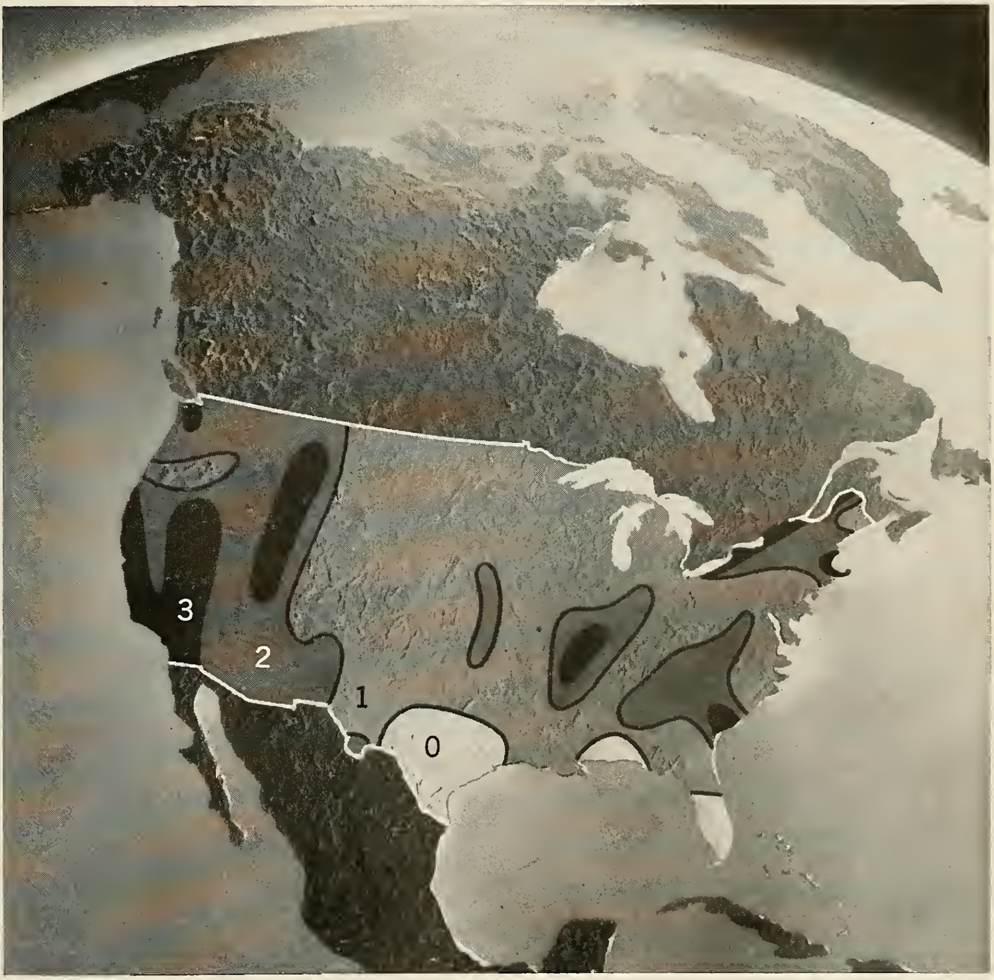
The destructive sea waves touched off by large earthquakes are popularly called tidal waves, although they have nothing to do with the tides. Seismologists call them seismic sea waves, or more specifically, tsunami, the Japanese term now in international use. They are a great danger on certain coasts, especially around the Pacific. Since such waves travel at speeds of, at most, a few hundred miles an hour, while the associated earthquake can be recorded on seismograms all over the world in twenty minutes or less, it has been possible to organize a warning service, operated by the U.S. Coast and Geodetic Survey with headquarters near Honolulu.

I am not an engineer, but I believe that buildings taller than thirty stories should not be constructed in earthquake country. I am willing to believe that first-class engineers can design such structures so as to make them moderately safe, but my confidence has been somewhat shaken by recent, serious damage to tall, modern-type buildings in Venezuela in 1967 and in Japan in 1968. More important is the social consideration: if the number of such tall structures continues to increase, an impossible weight of responsibility

Earthquake intensities that may be expected in different parts of the conterminous United States are shown on this map, adapted from one issued by the United States Coast and Geodetic Survey. The map does not show expected intensities in Mexico, Canada, or Alaska. Potential earth motions are: nil in the light zones (0); minor in the light gray (1); moderate in the dark gray (2); and major in the dark zones (3). The map does not indicate the frequency of earthquakes.

will be thrown on local agencies, such as city building departments. These offices are already understaffed and overworked; moreover, it is a little naïve to imagine that their personnel will always be perfectly competent and incorruptible.

The Alaskan earthquake of 1964 revived in the United States the old popular demand for earthquake prediction. Many competent seismologists and geophysicists believe that with our increased knowledge of earthquakes and our improved instrumental techniques we can approach the matter with at least some hope of success. At the request of the Johnson Administration, a panel of experts drafted and budgeted a plan for the appropriate investigations. It was never funded, but several government agencies and a number of private institutions have carried forward parts of the program. Meanwhile, similar programs under government sponsorship have gone forward in both Japan and the Soviet Union. In those countries, as well as in the United States, much new information of scientific interest has been developed; for instance, the demonstration of continuous slow motions, or "creep," along active faults, with or without earthquakes. I, however, do not share the enthusiasm of those who have hailed each such result as a definite step toward useful prediction. Much investigation has lately been directed toward the possibility of setting off earthquakes artificially; and some workers, whose scientific ability and judgment I regard with respect, have even held out a hope of "preventing" earthquakes. In our present state of information and techniques, that last is a goal about as remote as Alpha Centauri.



SKY REPORTER

MORNING COMETS Early-rising amateurs were rewarded with two bright comets in September and October. In late September Comets Fujikawa (1969d) and Honda-Mrkos-Pajdusakova (1969e) were just eight degrees apart in the morning sky, both about 8th magnitude.

The first was a new comet discovered by Shigehisa Fujikawa of Onahara, Japan, on August 12 when it was at 11th magnitude. First seen in Orion, the comet moved southeastward through Canis Minor, Cancer, below Leo, and into Virgo.

The second was a periodic comet picked up on this return by Czechoslovakian astronomers on August 12 at about 15th magnitude; it moved rapidly southeastward from a high circumpolar position through Camelopardalis, Lynx, and Leo into Corvus. Honda-Mrkos-Pajdusakova returns every 5.2 years from an aphelion of 275 million miles, more than halfway to Jupiter.

MOON SAMPLE, ANYONE? Some 700,000 years ago a meteorite three miles across plowed into the moon, gouged out the crater Tycho and blasted tons of material 240,000 miles across space to the earth. Fragments showered Australia, the Philippines, and southeast Asia in an S-shaped pattern.

These are the conclusions of Dean R. Chapman at NASA's Ames Research Center in California, who for ten years has studied tektites, the glassy fragments long suspected to have originated in meteor impacts on the moon. Tektites have been found in many parts of the world, and are readily available from mineral dealers and museum shops.

Chapman first saw tektites in the British Museum ten years ago. An aeronautical engineer, he recognized that they had been shaped by ablation during entry into the earth's atmosphere from space. He has since reproduced them in wind tunnels at Ames.

The tektites cannot be meteors themselves because they lack an aluminum isotope produced by cosmic-ray bombardment during long periods in space. They are associated with meteor impacts, however, because meteor fragments have been found in many of them.

The next step was to find the site of a meteor impact where the tektites might have been fused into glass by the impact heat and at the same time blasted into space. No crater of proper size and age is known on earth, and no spokelike pattern of tektite landings leads back to a specific impact point.

Chapman then tried computer runs of hypothetical trajectories from the moon. After thousands of trials, he found that only a shower of objects originating at Tycho could have produced the landing pattern found on the earth. The path follows the Rosse ray across the moon, a bright band of ejected material stretching a thousand kilometers from Tycho.

He also has been able to chemically relate the composition of the Australasian tektites with that of the rock on Tycho's rim, as determined by Surveyor 7 when it landed there in 1968.

If the tektites truly are moon samples, then scientists already have tons of lunar material at their disposal. Its scientific value is limited, however, because the record of what minerals were present was largely obliterated in the process of fusing into glass.

NOW A GAMMA RAY STAR The inevitable seems to have been discovered on two balloon flights in Australia last February—the first point source of gamma rays in the sky, or a "gamma ray star."

Gamma rays are the most energetic of the entire electromagnetic spectrum. Astronomers have moved in both directions from the visible-light part of the spectrum in which the science started. Radio astronomers use the less energetic, longer-wave portions. To move into the more energetic areas, astronomers have had to get above the atmosphere. An orbiting observatory is measuring ultraviolet radiation; rocket-borne instruments have found 40 X-ray sources. Now the most energetic of all have been detected by spark chambers hanging from balloons at 80,000 feet.

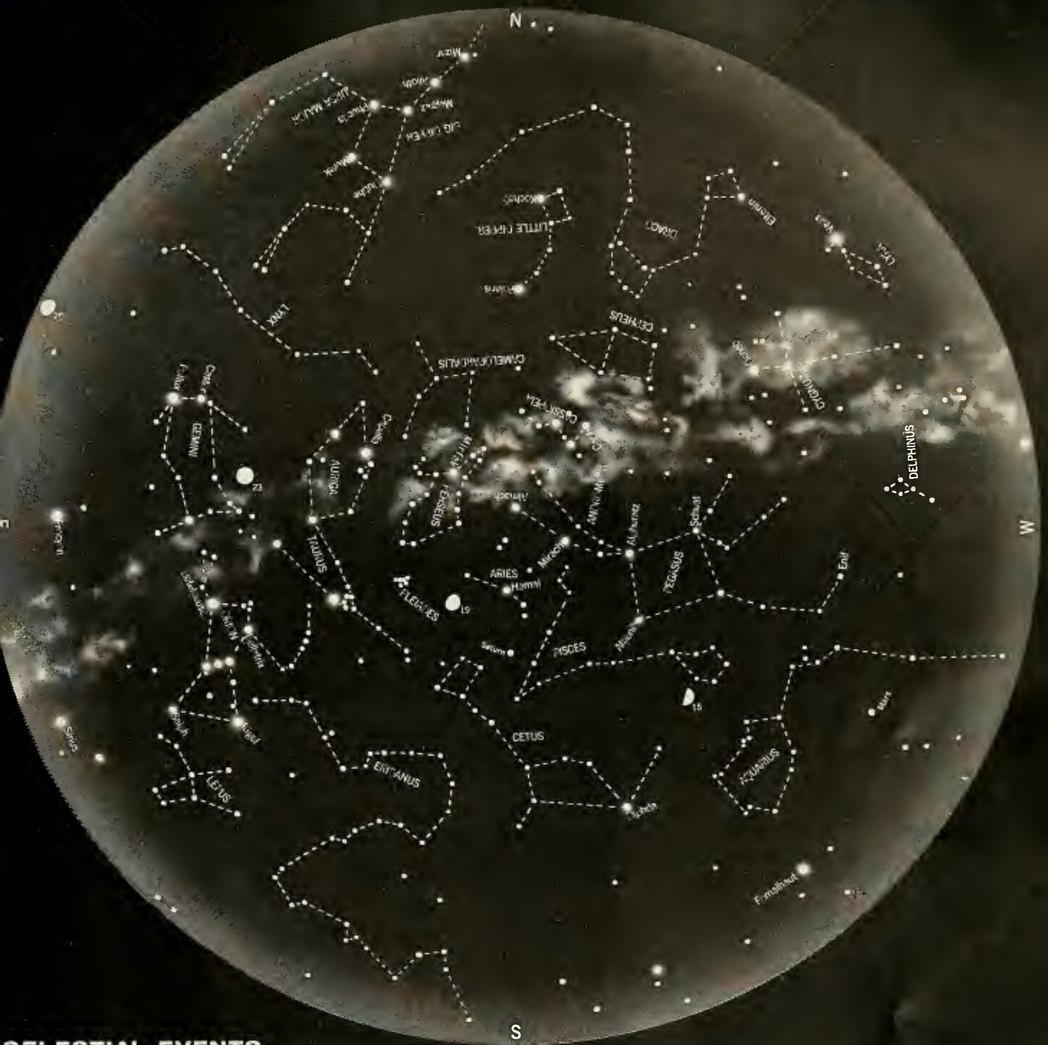
The detectors were flown by teams from Case Western Reserve University and the University of Melbourne; results were published in the British journal *Nature*. The new source, called Sgr γ-1, is in the constellation Sagittarius.

PROFILE OF AN ASTEROID Asteroids are generally believed to be irregularly shaped chunks of rock spinning randomly as they revolve around the sun between the orbits of Mars and Jupiter. There are thousands in the catalogs, but few receive much attention. They are faint, fast moving, and hard to find. Much can be learned from even a fast-moving speck of dim light; witness some recent deductions from one asteroid's magnitude fluctuations.

J. L. Dunlap and Tom Gehrels of the Lunar and Planetary Laboratory in Tucson used four telescopes on three continents to measure the fluctuations of an asteroid named Hektor, one of the Trojan group. They found it appeared to rotate in just under seven hours, and that its apparent brightness changed during a single cycle anywhere from more than a magnitude to just a tenth of a magnitude.

Writing in the *Astronomical Journal*, Dunlap and Gehrels maintain that Hektor is cylinder-shaped, with rounded ends, about 70 miles long and 25 miles wide. They find its axis of rotation is close to the ecliptic; this means that in one position in its orbit, we see Hektor from above its equator, alternately seeing its full length and then just one end of the cylinder. At another point in the orbit we see Hektor from above its pole; we always see its full length and the magnitude hardly varies.

John P. Wiley, Jr.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Eltanin
Vega
LYRA
LYNX
CEPHEUS
Deneb
CYGNUS
CAMELOPARDALIS
CASSIOPEIA
Castor
Pollux
GEMINI
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Capella
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CETUS
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CELESTIAL EVENTS

The moon is in the morning sky at the beginning and end of December, in the evening sky for the two middle weeks. Last-quarter moon is on the 1st; new moon on the 9th; first-quarter on the 15th; full moon on the 23rd; and last-quarter again on the 31st.

Mars, Saturn, and Mercury are evening stars; Mars in the southwest in early evening; Saturn up in the east at dusk and setting before dawn; and Mercury low in the southwest for the last ten days of the month. Jupiter is a morning star, rising in the east well before sunrise. Venus is too close to the sun to be seen.

December 4-5: Jupiter is to the left of the rising moon on the morning of the 4th; to the right and above the moon on the 5th.

December 13: The Geminid meteor shower is at maximum, with no moonlight during morning hours. An hourly rate of 50 meteors per single observer is expected.

December 13: Mars is to the left of the moon tonight.

December 21: The sun arrives at the winter solstice at 2:44 P.M., EST. Winter now begins in the Northern Hemisphere.

December 27: Mercury is at greatest elongation (east) in the evening sky, but only about 12 degrees above the horizon at sunset.

December 28: The moon approaches very close to Regulus, brightest star of Leo, in this morning's sky. The moon occults the star after 9:00 A.M., EST, during daylight in eastern North America, but before sunrise for observers in central and western regions.

THOMAS D. NICHOLSON

★Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 9:20 P.M. on December 1; 8:25 P.M. on the 15th; and 7:20 P.M. on the 31st; but it may be used for about an hour before and after those times.

THE CLOTH OF THE QUECHUAS

by Grace Goodell

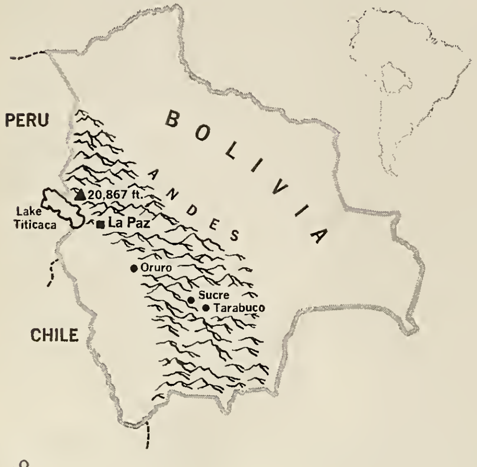
When Manco Capac, the legendary founder of the Inca Empire, and his sister-wife, Mama Ocllo, emerged from the ground near Cuzco and crossed the Andean highland with their entourage, the poets tell us that it was their resplendent garments, above all else, that measured their nobility. "They went forth clothed in dresses of fine wool delicately worked with fine gold thread, and from these they took out purses, also of wool and gold, skillfully woven. . . ."

To understand the significance of textiles to the Incas, the ancient craft of weaving has to be seen as a major art medium, for long before the Spanish conquest textiles had become a measure of national wealth. As techniques were perfected through time, remarkable artistry developed. Textiles were collected as taxes, used in ceremonial rituals, and distributed to officials and to armies. The peasant valued the works of the loom for himself as well because then, as often now, he depended on weaving for all his clothing, his containers for transportation and storage, his furnishings. Thus the importance of textile production pervaded the culture at every level and is naturally expressed in its myths.

It is no wonder then that the high quality of weaving should have been the prime indicator of personal excellence in the Andes. In some areas even today the Quechuas, direct descendants of the Incas, still consider the skills of hand spinning, dyeing, and weaving to be the essential criteria of human dignity.

But each year there are fewer and fewer people who wear the old garments, fewer who spin and weave. Soon it will be impossible to collect some of the textiles I saw on a recent survey of Indian weaving in Bolivia. Even now the best weavers are reluctant to sell their rare pieces, and just to see such craftwork requires traveling to the remotest regions. There, usually in an isolated valley, the geography itself has helped to preserve with little change the subtleties of the art as they were developed by pre-Columbian cultures. The land is rugged, men are isolated, and ancient techniques have not been compromised by proximity to large towns.

In the Bolivian highlands, three major areas of special weaving interest are apparent. The greatest variety of weaving techniques is found in the area east of Oruro. Here it is not uncommon to see five or more distinct means of textile production being employed by different members of one family, all in one courtyard on the same afternoon. Their looms range from the indigenous and most ancient to a later type introduced by the Spaniards and often constructed with a twentieth-century



Weaving excellence remains a source of pride in remote Indian communities of Bolivia's rugged highlands. An example of the intricate craft is this woven figure on the strap of a man's *capacho*, or purse, from a hamlet north of La Paz. Such designs are distinctly local, and on market day they help identify each visiting Indian's home valley. The back of the figure is shown on the following page.

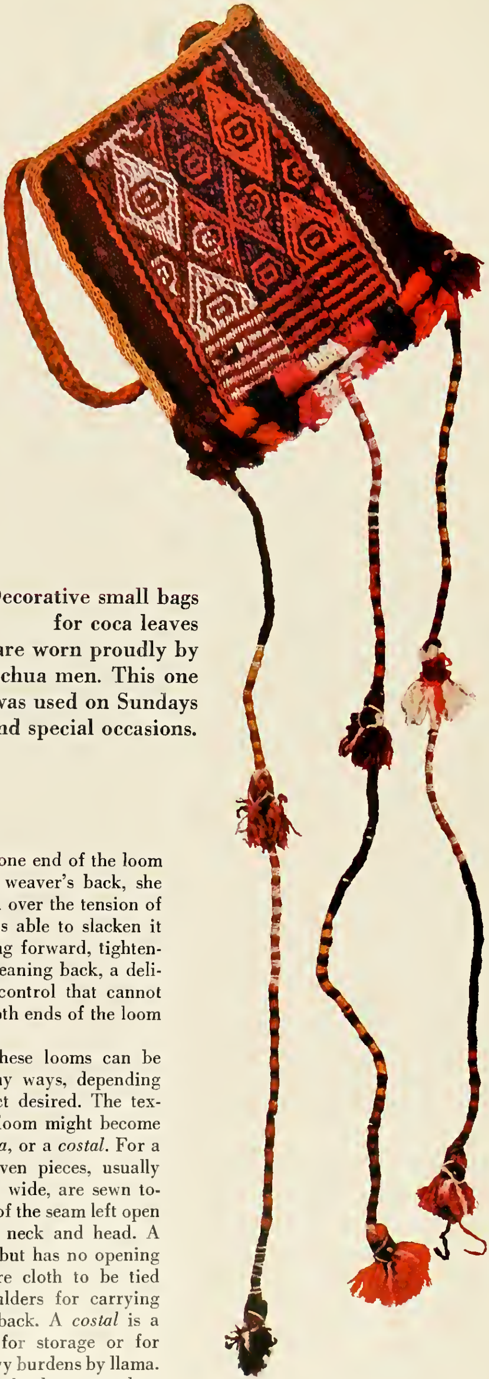
touch—an axle from an old Ford, for example, or bolts from a Toyota truck.

Nowhere else in the southern Andes have I seen a region so vitally concerned with weaving. The variety of weaving techniques and looms in this area reflects the extent and diversity of the Indians' weaving needs, and the significance of weaving to their daily lives. Furthermore, while in many parts of Bolivia (and southern Peru) only women spin yarn outside of the home, here it is commonplace for men and boys to spin outdoors as they gossip or tell stories in the winter sun. Even the more sophisticated Indian boys, who have just returned to their small hamlets from army service or cuttting cane in the jungle, take up the spindle readily. And it is in this region that weaving is still the critical measure of material worth: a boy weaves a belt for a girl before proposing to her; she weaves a coca bag for him in consent. Farmers barter textiles for coffee, buttons, tin cups. At regional celebrations there is rivalry among communities to establish or preserve a collective reputation for weaving excellence.

Of all the area's assortment of looms, the principal one is the backstrap, typical of primitive craftsmen throughout the Andes and elsewhere in the New World and parts of Asia. It consists essentially of two horizontal loom bars supported a foot or more above the ground, with the warp (lengthwise yarns) extended between them. One end of this loom is fastened around the waist of the weaver, who sits cross-legged on the ground; the other end is tied to a tree or post, which he faces. In Andean prisons where Indians weave all day, having nothing else to do but cook their own meals, one can see six or more such looms spread out like a Maypole from the jail yard's central loom post.

Sometimes weavers tie what would otherwise be a backstrap loom to four pegs in the ground, rather than tire their backs with its constant support. Or they fasten the loom to two long vertical poles that lean against the wall of the house. However, neither of these adaptations allows for the same subtleties as the backstrap: with one end of the loom tied around the weaver's back, she has more control over the tension of the warps. She is able to slacken it merely by leaning forward, tightening it again by leaning back, a delicate nuance of control that cannot be achieved if both ends of the loom are fixed.

The size of these looms can be modified in many ways, depending upon the product desired. The textile on a larger loom might become a poncho, a *lliclla*, or a *costal*. For a poncho, two woven pieces, usually two to three feet wide, are sewn together with part of the seam left open for the wearer's neck and head. A *lliclla* is similar but has no opening —a strong square cloth to be tied around the shoulders for carrying bundles on the back. A *costal* is a long sack used for storage or for transporting heavy burdens by llama. *Costales* around the house tend to look lean and hungry toward sum-



Decorative small bags for coca leaves are worn proudly by Quechua men. This one was used on Sundays and special occasions.

mertime, but they are filled to bulging after harvest.

A smaller backstrap loom produces belts, straps, and coca bags, as well as small *costales*, in which a family keeps household luxuries and necessities—thread, a spoon, sugar, a spare candle. Village medicine men display their remedies in these *costales* on market day—bits of yellow pods, dried starfish, crushed sulfur, cactus thorns, or withered herbs, each sold from its own little sack. Headbands, saddlebags, capes, and purses are other common products of the backstrap loom.

In addition to the backstrap, the Indians of the Oruro region use a crudely made lap loom, on which they create belts using a Soumak-type technique, in which the wefts encircle the warps instead of interweaving with them. Often patterned with a bold, zigzag design of striking colors, such belts are only made by men and boys for their wives and girl friends. Making them is indeed a man's task, for they are exceedingly thick and must be firmly bound and interlaced. This type of loom was also used by pre-Spanish weavers in Peru. Today it has a specialized and highly appreciated place in the weaving repertoire of this area.

Farther southeast from Oruro, Indians weave rugs and blankets, mainly for commercial use, on upright frame looms. This enormous loom fills the weaver's hut from the rafters to the floor. Beautiful Spanish designs in a tapestry weave have characterized these rugs, but more recently, contemporary patterns have been suggested by Peace Corps volunteers. Also ubiquitous in the Oruro region is the treadle loom introduced by the Spaniards. Most remote communities here possess several treadle looms; it is on these looms that the men weave *bayeta* (a coarse woolen cloth for pants, vests, shirts, and women's skirts), as well as gay plaid sashes. Young boys in particular sport these sashes tied low below the waist with studied casualness. And because they are also used for weaving blankets, three or four treadle looms—one for each member of the family—may be going at one time in an Indian home.

In addition to these, there are smaller looms and methods of off-the-loom weaving and braiding that these Indians have at their disposal. The younger children sit on the ground, legs outstretched, working on a toe loom that may have as many as five or six heddles. They make straps and hat bands, often with elaborate designs. Using still other techniques they make *ribete*, the narrow edging along a poncho that protects it from fraying. Boys braid numerous strands into complex "snakeback" slingshots, which broaden out into a short woven strap where the stone will be held; they also produce splendid llama-hair rope. Finally there are the soft alpaca *tulas* with their colorful pom-poms —a kind of ribbon specially made to hold a woman's long braids together behind her back while she stirs the soup or bends over the baby.

In this area of Bolivia, where textiles are so important in daily life, even the spirits of the mountains value the yarn and the loom. In communities like Ayrampampa, Saint Isidore, the patron of farmers and a peasant himself, must also have a poncho; so a local weaver is commissioned to keep his statue well attired with a bright new garment on his feast day every year. Furthermore, at planting and harvesttime the earth goddess may demand her annual tribute wrapped in a specially woven cloth. To ward off evil spirits, magical *lloq'e*, a yarn spun in the reverse direction from the normal spinner's twist, is tied around the ankle or wrist. This is worn by travelers, pregnant women, the ill—by anyone hoping for good luck. Even the statues of saints in the churches sometimes find it advisable to wear *lloq'e* on their wrists. No one can survive without the loom.

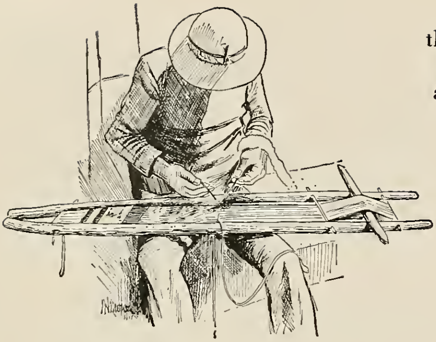
In northern Bolivia beyond La Paz, weaving takes on a different mood. This region, Ayata, Charazani, and on out to the Peruvian border, is a series of deep valleys set among magnificent, soaring mountains; the communities own fewer llamas and alpaca, so most of the weaving is done with sheep's wool. Because of its nature, that is, its scale structure and kinkiness, sheep's wool is usually easier to spin than alpaca or llama hair. With it the Charazani spinners produce some of the finest of present-day highland yarns.

With all fibers like wool or hair, spinning is indispensable for weaving, and a high level of weaving can hardly flourish without good spinning. Throughout Bolivia the Indians spin with a drop spindle similar to that used elsewhere in the world: a slender stick nine or ten inches long with a round whorl toward the bottom for balance. Because it can be used even while the spinner walks or runs, it is not unusual to see heavily loaded Indian porters from the mountains industriously working the spindle, which dangles and swings by their legs as new yarn is formed.

Children learn to spin at an early age. Lying on the ground near many an Indian hut are toy spindles with bits of wool; some of the finest yarn is spun by young girls under ten.

A good spinner controls the diameter of his yarn by a sensitive fiber-selecting process, which he performs almost unconsciously with his fingers, thinning out the fiber bundles as he feeds them into the yarn he is twisting. All careful spinners aim for an even yarn without noticeable variation in its diameter. Only in areas where craftsmanship has declined and the spinners have become indifferent—often they are embarrassed by this when questioned —does one find yarn spun with considerable irregularity. In a few regions, spinners may deliberately produce such crude yarn to suit the tourist market. Tourists often cannot believe that the skillfully spun yarn is indeed hand-spun, and will pay more for proof in irregularities. Generally these "lumpy" yarns are more frequently found in knitted wear, especially sweaters, as it would be

Whimsical animals parade on an *aksu*, or cape, from an isolated area near Sucre. The pictorial fantasies of this region require particular artistry because several figures evolve simultaneously across the loom.



Using a technique that requires strength, men from the Oruro area make thick belts on lap looms.

difficult to use them extensively on a native loom.

After the wool is spun into yarn, it is plied; that is, two or more yarns are twisted together to make a stronger yarn. This is usually a man's work, although I have never known an idle woman who would not pick up the plying when the need arose. The men ply the yarn at home or while working, using a larger and heavier spindle than that used in the original spinning of wool. When all the wool has been spun and plied, it is ready for dyeing.

In a few areas of the southern Andes, and especially in the isolated north of Bolivia, vegetable, animal, or mineral dyes are still used, but in very little time the recipes and processes will be forgotten, replaced by commercial dyes. And sooner still, no one will any longer know on which hill to pick the brightest *cher'chi*, or exactly on which day its dye will be the subtle shade desired. Dyeing is a lore and a science unto itself, and requires a thorough knowledge of local geography, botany, and geology, as well as expertise in mixing mordants (which fix the dye to assure permanence); in timing the boiling, steeping, and cooling; and in anticipating color modifications that may take place with temperature change or variations in wool composition.

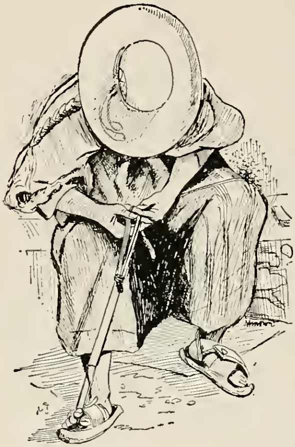
Three natural dyes most popular today in Bolivia and southern Peru are nogal, or walnut tree leaf, for browns and yellows; dried and powdered cochineal insects for rich red shades; and plain house soot from the cooking area of the hut for black and brown. Common mordants are lemon juice, urine, or fermented corn beer, although it may be that these are widely employed without any tested evidence of their value. Probably the deep blue of the northern headbands and coca bags dates only to the importation of indigo during this past century.

An interesting feature of weaving in some of these northern valleys is its extremely local character. In this region—perhaps here alone of all the regions in Bolivia—each community has its own distinctive motif variation or color rendering. Thus a person familiar with these local characteristics can stand in the Ayata market on Sunday and identify the exact valley of each visiting Indian, even his particular hamlet in that valley. This is done by closely examining his *capacho,* a foot-long, flat bag carried by men.

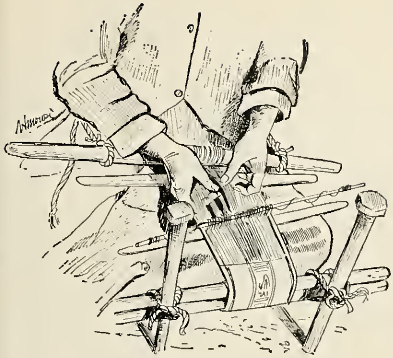
Many of the marks of differentiation are obvious; they are simply distinct patterns. However, there are others that may appear identical to the unpracticed observer. Nevertheless, the indications are consistent and are never omitted: a geometric form may be elongated, instead of rounded out; birds other than ducks may decorate a narrow band; a "rainbow" warp may be used in place of a solid shade. To the weavers these are as much a part of the design as are the major motifs.

Despite such a seemingly compulsory code, the creativity of the craftsman is never inhibited. This artistic use of a local pattern can be compared to the development of a theme in a fugue: the theme clearly distinguishes one fugue from others but in no way limits the freedom of the composer. Rather, it provides him with challenge and form. The Ayata *capachos* from a single hamlet are never the same, but each manifests the local "theme" in a slightly new way, within its implicit local restrictions.

Elsewhere in Bolivia weaving designs tend to characterize much larger geographic areas, a single theme extending at least across a wide pampa or a valley. That many of these tiny communities near Ayata, perhaps only half an hour



Although the toe loom is simply constructed, children can weave elaborately designed straps and hatbands on it.



With one bar of the small backstrap loom tied around her body, the weaver controls the warp tension by leaning forward or back.

apart on foot, can preserve such individuality in their textiles is indicative of the Indians' attitudes toward weaving. Their handmade garments are part of their identity, sometimes even more so than their names, many of which are common throughout the entire region. This localization of weaving designs is also found in parts of Central America and in the Cuzco area of Peru. What will be the reaction of these people as the commercial clothing industry drives the hand loom from their valley in the near future, and they have to wear shirts identical to those worn over a vast geographical area by total strangers?

There are many other distinct regional motifs and color characteristics in Bolivia. We have not discussed the lowland and the jungle craftsmen and their work, the special weaving of the Indians in the mines, or the less imaginative weaving of the Aymara tribe. These groups present interesting problems in themselves, but they too will soon lose the craft.

In some respects the most exciting textile region in Bolivia is around Sucre, the original capital of the country. It is in this area that the anthropologist is most strongly challenged by questions of artistic creativity: How does a primitive artist conceive the idea of his work and then enter into its elaboration? Does a craftsman deep in a weaving tradition in any sense enjoy a spontaneity comparable to that of, say, a potter or water-colorist? Why make weaving difficult with designs? The region around Sucre lends itself well to the study of influences that foreign cultures, penetrating farther into the backlands, may bring to bear upon the primitive artist.

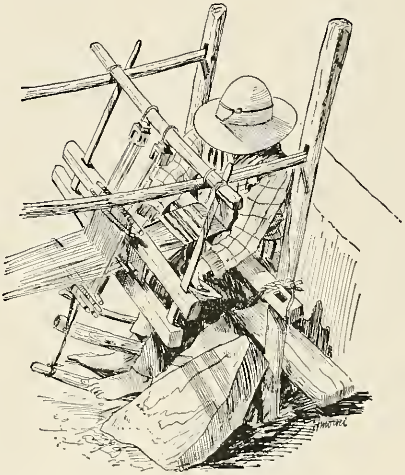
Although it has been reported that weaving samplers are used in the central Andes, I have never seen anything that might serve as a sampler, and in fact the creative tradition communicated to me by weavers would have no room for such an aid. Most weavers of several years' experience are so thoroughly acquainted with the motifs used in their village or region, and with the manipulations possible on their looms, that weaving these motifs or transmitting them to a beginner needs no record or reminder. It is true that young weavers may often be seen using a finished product as a model, especially while warping the loom. But as soon as the first few rows of weft (the horizontal yarn) have been finished, they usually find picking out the design of one row to be a logical sequence based on what has been done in the row immediately preceding it.

However, except in pieces requiring continual repetition of a single motif, there is considerable opportunity for creativity. Most weavers invent as they go along, sometimes carrying and developing in their minds numerous different design sequences across the width of the loom at one time.

If the design sequences consist of geometric patterns, complex mathematical calculations are frequently required to work them out, especially on the backstrap loom. And if the designs are representations of men, plants, or animals, as many as five or six distinct figures in different stages may be emerging simultaneously across the loom. Yet no weaver has ever reported sketching out the over-all pattern beforehand, most do not even have the finished design firmly in mind from the start. This process does of course depend upon the creativity of the weaver, his experiences, perhaps his daring—and his humor.

On several occasions I have been able to compare eight or ten weav-

Continued on page 64



A boy weaves a sash on a Spanish treadle loom, which is also used to produce the coarse woolen homespun for his clothing.

ANIMAL AGES

Formulas estimate life-spans and relative ages of man and other animals

by David P. Willoughby

When comparing the ages of other animals to that of man, many people relate the ages by a direct ratio. Thus a dog's age is popularly supposed to be one-seventh that of a man, so that a dog seven years old is equivalent in age to a man of 49 years. But there are problems in this type of reasoning. The oldest dog on record, for example, lived to the age of 34 years. Hence, according to the 1 to 7 theory, a man could live to 34 × 7, or 238 years. This is more than twice the greatest reliably recorded human age. Again, a dog of 1.5 years is not equivalent to a human seven times that age, or 10.5 years, but to one of 21 years, because the dog and the man reach the adult stage at about 1.5 years and 21 years, respectively.

Therefore to compare the developmental ages of other mammals to that of man, it is useful to develop a sliding scale or ratio, which would take into account both the time required to reach maturity and the maximum age recorded for the species being compared.

In table 1, data are given for man and several familiar species of lower mammals, as follows: average age at maturity; average age at death; maximum recorded, or estimated, age;

and maximum age according to my prediction formula. It is interesting to note that the average age at death for man, dog, cat, horse, and cow is in each case equal to 3 times the age at maturity plus 7 years. On this basis the gorilla (lowland species), which in the male reaches maturity at about 12.5 years, should have an average age at death of 44.5 years. Yet the highest maximum age recorded for this ape is 33.5 reached by Bamboo, a male lowland gorilla that died in the Philadelphia Zoo in 1961. On the same basis the chimpanzee, which reaches maturity at 11 years, should have an average life-span of 40 years. One zoo specimen reached 39 years; but it would appear that the potential maximum age in both the chimpanzee and the gorilla is about 60 years.

The elephant is another nonconformist, since it takes about 25 years (some authorities say even 30 years) to reach maturity, yet lives only to an average age of not more than 60 years. A maximum age of 77 years is on record for an Asiatic elephant, although much higher ages have been claimed. In the light of our present knowledge, it would appear that 80 years, possibly 85, is the potential maximum age of the elephant. The life-span of the largest whales, which was once thought to be several hundred years, is now estimated at 50 to 60 years.

Many a relatively high age has been claimed for both dogs and cats. The biologist Alex Comfort, who has made an extensive study of animal longevity, has shown that smaller breeds of dogs (spaniels, pekinese) have an average life-span of about 11.5 years, whereas larger breeds (mastiffs, wolfhounds) average only about 7 years. While Comfort lists the maximum canine longevity at 24+ years, the + must be at least 10 years, since a dog of 34 years is on record. Because the cat is a smaller animal than the dog, and reaches maturity at an earlier age, one would expect it to have a shorter life-span than the dog; yet ages of 35 years and even more, are on record. Possibly these feline oldsters enjoyed a more sheltered life than other, outdoor-living animals.

For a long time, a record age of 62 years for the domestic horse was generally accepted as authentic. This age pertained to a Manchester, England, canal horse that died in 1822. This "record" would appear to be unsubstantiated, like the alleged ages of 125 to 160 years attributed to some persons. Certainly, if the age records of many claimed human centenarians are undocumented and unacceptable, the asserted records of many lower animals are even more suspect. Comfort has provided authentic survival curves for 419 British thoroughbred mares. The average age at death of these horses was 22 years, and maximum age attained by any one of them was 31 years. On this basis it can be estimated statistically that only one horse in 500,000,000 should be expected to reach 40 years. A donkey has been known to reach 47 years, a zebra 38 years, a mule 43 years, and a shetland pony 48 years.

While various animals conform well, and certain others not so well, with the theoretical maximum ages that could be expected for them, all, nevertheless, would seem to range within fairly narrow limits when the chief factors relating to longevity are taken into account. A number of authors have established the relationship of heartbeat rate to body weight and of heartbeat rate to longevity. My studies show that brain weight is also a major factor in longevity. For example, the highest recorded age for the raccoon, a relatively large-brained carnivore, is nearly 14 years; for the opossum, a small-brained marsupial of about the same body size, it is only 7 years. The heartbeat rate varies inversely with the size of the animal, the general formula being: heartbeats per minute = body weight$^{-0.27}$. If the number of heartbeats per minute is multiplied by the square root of the brain weight in grams, and the product divided into the maximum known age of the animal in question, the resulting figure ranges only between 4.00 and 5.00. In man and the horse, it is about 4.30; in the dog, 4.34; in both the mouse and the ele-

Table 1.

COMPARATIVE AGES, IN YEARS, OF MAN AND SOME LOWER ANIMALS

Species (*all males*)	Average age at maturity	Average age at death	Maximum age Reported	Maximum age Predicted
Man	21	70	115+	117
Elephant, *Asiastic*	25?	60?	77+	80
Camel	8	31?	40+	54.5
Horse	5	22	40+	42.5
Cow	4	19	30+	38.5
Dog	1.5	11.5	34	33.3
Cat	1	10	35?	36
Sheep	1.5	9	15+	20.5
Mouse	66-67 days	2.2	6?	9.2

phant, about 4.00 (a remarkable conformity); and in the cat possibly as high as 5.00. All other mammalian species appear to range between 4.00 and 5.00, so that on this basis the potential individual longevity of any mammal may be estimated usually within ± 10 percent. Accordingly, where a claimed age, either for a person or a lower animal, falls outside a range of + 10 percent from the calculated age, it is subject to question.

A "prediction formula," to fit the observed data as closely as possible, is not often a simple equation, or "rule of thumb," and in some instances may be exceedingly complex. Fortunately, my formula for estimating the potential maximum age of a mammalian species is relatively simple, and requires only two items of information. One of these is the average age at death, B, and the other is the average, or typical, age at maturity, A. The ratio of the potential maximum age, C, to B is $C/B = 0.32\ B/A + 0.6$. Thus the potential age for man is:
$C/70 = [0.32\ (70/21) + 0.6]$, or $C = 70 \times [0.32\ (70/21) + 0.6] = 117$ years. All the potential ages of the other mammals listed in the foregoing table have been calculated by this formula. The only animal about which there may be a question is the mouse, for which the formula gives a potential age of more than 9 years, which seems excessive. Yet that is the age to be expected from the mouse's brain weight and heartbeat rate.

Table 2 lists the relative ages, based on the foregoing formula, of man and his most familiar animal companions: dog, cat, and horse. For these animals the specific conversion formulas are:

Dog's age = .333 man's age − 5.5
Cat's age = .385 man's age − 7.0
Horse's age = .406 man's age − 3.5

Using these formulas for elderly members of each species, for example, we find that a dog of 28 years, a cat of 32 years, or a horse of 38 years is equivalent in age to a man of 102 years. The maximum ages in table 2 are subject to debate, but it seems unlikely that they have ever been exceeded for the species in question.

Table 2.

RELATIVE AGES, IN YEARS, OF MAN AND SOME LOWER ANIMALS

Man	Dog	Cat	Horse
20	1.2	0.7	4.6
25	2.8	2.6	6.6
30	4.5	4.6	8.7
35	6.2	6.5	10.6
40	7.8	8.4	12.7
45	9.5	10.3	14.8
50	11.2	12.2	16.8
55	12.8	14.1	18.8
60	14.5	16.1	20.9
65	16.2	18.0	22.9
70	17.8	19.9	24.9
75	19.5	21.8	26.9
80	21.2	23.8	29.0
85	22.8	25.7	31.0
90	24.5	27.6	33.0
95	26.1	29.5	35.1
100	27.7	31.5	37.1
105	29.4	33.4	39.1
110	31.1	35.3	41.2
115	32.7	37.2	43.2
120	34.4	39.2	45.2

This table of relative ages is based on the author's formula. In the case of a four-year-old dog, the table agrees approximately with the older rule of thumb that multiplying a dog's age by seven will give the equivalent human age. The table produces a different answer, however, for a dog that is younger or older.

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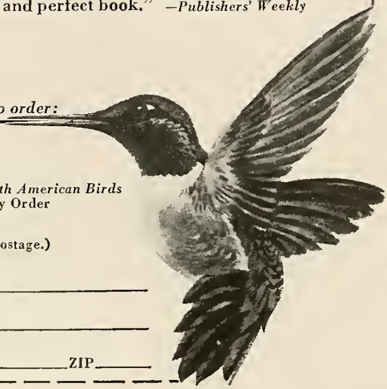

Then, freshly cut branches were heaped around the fallen carcass to receive the meat. Ten men volunteered to help with the cutting. I asked /gaugo to make the breast bone cut. This cut, which begins the butchering process for most large game, offers easy access for removal of the viscera. But it also allows the hunter to spot-check the amount of fat on the animal. A fat game animal carries a white layer up to an inch thick on the chest, while in a thin one, the knife will quickly cut to bone. All eyes fixed on his hand as /gaugo, dwarfed by the great carcass, knelt to the breast. The first cut opened a pool of solid white in the black skin. The second and third cut widened and deepened the creamy white. Still no bone. It was pure fat; it must have been two inches thick.

"Hey /gau," I burst out, "that ox is loaded with fat. What's this about the ox being too thin to bother eating? Are you out of your mind?"

"Fat?" /gau shot back, "You call that fat? This wreck is thin, sick, dead!" And he broke out laughing. So did everyone else. They rolled on the ground, paralyzed with laughter. Everybody laughed except me; I was thinking.

I ran back to the tent and burst in just as Nancy was getting up. "Hey, the black ox. It's fat as hell! They were kidding about it being too thin to eat. It was a joke or something. A put-on. Everyone is really delighted with it!"

"Some joke," my wife replied. "It was so funny that you were ready to pack up and leave /ai/ai."

If it had indeed been a joke, it had been an extraordinarily convincing one, and tinged, I thought, with more than a touch of malice as many jokes are. Nevertheless, that it was a joke lifted my spirits considerably, and I returned to the butchering site where the shape of the ox was rapidly disappearing under the axes and knives of the butchers. The atmosphere had become festive. Grinning broadly, their arms covered with blood well past the elbow, men packed chunks of meat into the big cast-iron cooking pots, fifty pounds to the load, and muttered and chuckled all the while about the thinness and worthlessness of the animal and /ontah's poor judgment.

lahari *Continued from page 22*

We danced and ate that ox two days and two nights; we cooked and distributed fourteen potfuls of meat and no one went home hungry and no fights broke out.

But the "joke" stayed in my mind. I had a growing feeling that something important had happened in my relationship with the Bushmen and that the clue lay in the meaning of the joke. Several days later, when most of the people had dispersed back to the bush camps, I raised the question with Hakekgose, a Tswana man who had grown up among the !Kung, married a !Kung girl, and who probably knew their culture better than any other non-Bushman.

"With us whites," I began, "Christmas is supposed to be the day of friendship and brotherly love. What I can't figure out is why the Bushmen went to such lengths to criticize and belittle the ox I had bought for the feast. The animal was perfectly good and their jokes and wisecracks practically ruined the holiday for me."

"So it really did bother you," said Hakekgose. "Well, that's the way they always talk. When I take my rifle and go hunting with them, if I miss, they laugh at me for the rest of the day. But even if I hit and bring one down, it's no better. To them, the kill is always too small or too old or too thin; and as we sit down on the kill site to cook and eat the liver, they keep grumbling, even with their mouths full of meat. They say things like, 'Oh this is awful! What a worthless animal! Whatever made me think that this Tswana rascal could hunt!' "

"Is this the way outsiders are treated?" I asked.

"No, it is their custom; they talk that way to each other too. Go and ask them."

/gaugo had been one of the most enthusiastic in making me feel bad about the merit of the Christmas ox. I sought him out first.

"Why did you tell me the black ox was worthless, when you could see that it was loaded with fat and meat?"

"It is our way," he said smiling. "We always like to fool people about that. Say there is a Bushman who has been hunting. He must not come home and announce like a braggard,

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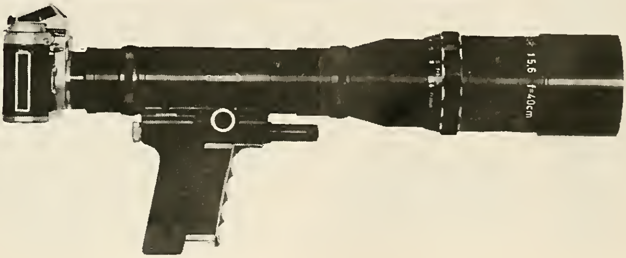

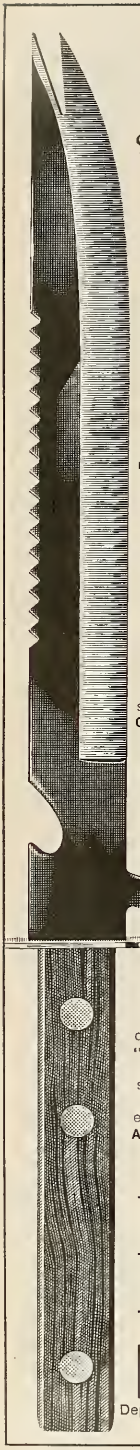

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'I have killed a big one in the bush!' He must first sit down in silence until I or someone else comes up to his fire and asks, 'What did you see today?' He replies quietly, 'Ah, I'm no good for hunting. I saw nothing at all [pause] just a little tiny one.' Then I smile to myself," /gaugo continued, "because I know he has killed something big.

"In the morning we make up a party of four or five people to cut up and carry the meat back to the camp. When we arrive at the kill we examine it and cry out. 'You mean to say you have dragged us all the way out here in order to make us cart home your pile of bones? Oh, if I had known it was this thin I wouldn't have come.' Another one pipes up, 'People, to think I gave up a nice day in the shade for this. At home we may be hungry but at least we have nice cool water to drink.' If the horns are big, someone says, 'Did you think that somehow you were going to boil down the horns for soup?'

"To all this you must respond in kind. 'I agree.' you say. 'this one is not worth the effort; let's just cook the liver for strength and leave the rest for the hyenas. It is not too late to hunt today and even a duiker or a steenbok would be better than this mess.'

"Then you set to work nevertheless; butcher the animal, carry the meat back to the camp and everyone eats," /gaugo concluded.

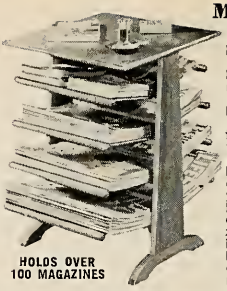
Things were beginning to make sense. Next. I went to Tomazo. He corroborated /gaugo's story of the obligatory insults over a kill and added a few details of his own.

"But," I asked. "why insult a man after he has gone to all that trouble to track and kill an animal and when he is going to share the meat with you so that your children will have something to eat?"

"Arrogance." was his cryptic answer.

"Arrogance?"

"Yes, when a young man kills much meat he comes to think of himself as a chief or a big man, and he thinks of the rest of us as his servants or inferiors. We can't accept this. We refuse one who boasts. for someday his pride will make him kill somebody. So we always speak of his meat as worthless. This way we cool his heart and make him gentle."



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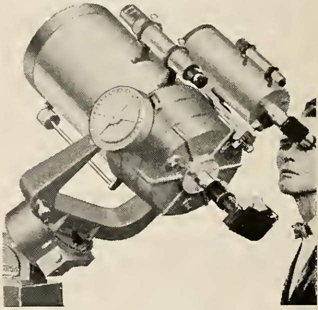

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"But why didn't you tell me this before?" I asked Tomazo with some heat.

"Because you never asked me," said Tomazo, echoing the refrain that has come to haunt every field ethnographer.

The pieces now fell into place. I had known for a long time that in situations of social conflict with Bushmen I held all the cards. I was the only source of tobacco in a thousand square miles, and I was not incapable of cutting an individual off for noncooperation. Though my boycott never lasted longer than a few days, it was an indication of my strength. People resented my presence at the water hole, yet simultaneously dreaded my leaving. In short I was a perfect target for the charge of arrogance and for the Bushmen tactic of enforcing humility.

I had been taught an object lesson by the Bushmen; it had come from an unexpected corner and had hurt me in a vulnerable area. For the big black ox was to be the one totally generous, unstinting act of my year at /ai/ai, and I was quite unprepared for the reaction I received.

As I read it, their message was this: There are no totally generous acts. All "acts" have an element of calculation. One black ox slaughtered at Christmas does not wipe out a year of careful manipulation of gifts given to serve your own ends. After all, to kill an animal and share the meat with people is really no more than Bushmen do for each other every day and with far less fanfare.

In the end, I had to admire how the Bushmen had played out the farce—collectively straight-faced to the end. Curiously, the episode reminded me of the *Good Soldier Schweik* and his marvelous encounters with authority. Like Schweik, the Bushmen had retained a thoroughgoing skepticism of good intentions. Was it this independence of spirit, I wondered, that had kept them culturally viable in the face of generations of contact with more powerful societies, both black and white? The thought that the Bushmen were alive and well in the Kalahari was strangely comforting. Perhaps, armed with that independence and with their superb knowledge of their environment, they might yet survive the future. ■

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The Cloth of the Quechuas

Continued from page 55

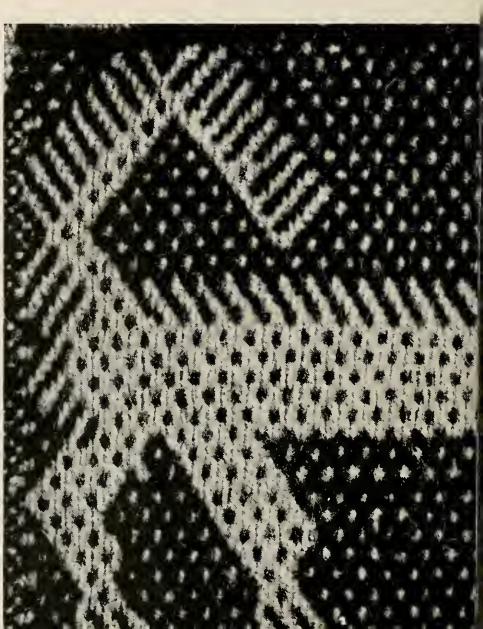
ings by the same craftsman, gathering them from neighbors and family in his village. Never did I find two pieces alike, although the diversity represented in the "portfolio" of any one craftsman depended upon his own creative energies, as is to be expected.

The area around Sucre includes great extremes in style of weaving designs. East of the city lies hilly land with very few roads. One may walk three days or more hardly seeing a person; then, after a casual inquiry in a hut, suddenly find it to be a region of the most imaginative, bizarre weaving motifs. Here, with finely spun yarn, hand-dyed in basic color combinations, weavers have set forth a fabulous parade. Red condor birds dive through purple backgrounds, scarlet bulls graze on a green field, cows have foxes inside their bellies. If you should laugh, the Indians will usually laugh with you at a comical spotted toad or a Wizard-of-Oz lion. After the bands of repeated geometric designs characteristic of weaving in much of the southern Andes, this burst of representational fantasy is startling.

On the other hand, not far away in the Tarabuco area the weaving is a complete contrast in color and spirit. There the designs are almost sinuous, highly baroque. In color harmonies that could never be achieved by natural dyes (and thus are subject to outside influence), intricate forms interlock abstractly. If any representational figures appear, they are likely to be stern horses and stiff riders, motifs derived from the Spanish tradition. Much of the yarn itself is commercially spun, which probably reflects Tarabuco's outside contacts as a tourist community.

In many other areas of the southern Andes I have observed a correlation between quality of hand-spinning and dyeing on the one hand and preservation of pre-Spanish designs on the other. This is not to say that such factors need always accompany one another. In Mexico, Indians who weave designs of motorcycles and political posters into their textiles maintain a very high spinning standard. However, it may be true that in Bolivia and southern Peru, a community that readily accepts the innovation of commercial yarn or dye, may also be a community with a more flexible attitude toward new, even foreign designs.

But wherever one searches in such a study, one thing is constant: it is not difficult to distinguish the craftsman who weaves with an artist's love of expression and a pas-



Even on coca bags in everyday use, the motifs often reflect the imagination and humor of the weaver.

sion for the mastery of his material, from the craftsman who works merely out of need. One woman I met near Sucre was typical of the former. Her husband, who shortly before our meeting had joined the work crew of a road being built near the community, was ashamed of his peasant clothes in his new job. Because a plain poncho devoid of all design indicates higher class among mestizos (the Spaniards never liked patterned ponchos, but instead considered solid black or gray to distinguish the true "caballero"), the Indian on a road crew is marked as a hillbilly by the brilliance and intricacy of his poncho. This man therefore demanded that his wife weave a solid gray poncho for him. He would no longer be seen in the garment it had taken her half a year to create. As she explained this, she wept. He had asked her to betray the very essence of her craftsmanship: for her, weaving without design was a contradiction.

She, like many a weaver in Bolivia, is among the last to serve a historic tradition preserved from one generation to the next for more than two thousand years: the skills and craft of textile production recorded only in the minds and hands, yet for ages so critical for survival in the Andes.

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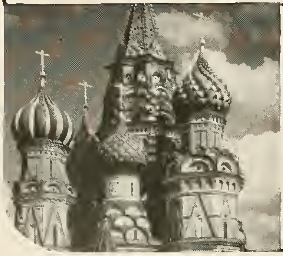

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This spectacular aerial view of a butte in southern Utah is an illustration from Kirtley Mather's "The Earth Beneath Us."

A Geologist's Guide to th

by William H. Matthews III

Like that of most professors, my office is full of books. And, not being the "clean-desk" type, books not only fill the floor-to-ceiling bookcases, which line the walls; they spill out into random piles that eventually cover desk, tables, and even chairs. Upon entering this bookish habitat, a student will frequently exclaim, "My goodness! Have you read all of these books?" Honesty, of course, compels a negative reply, for while I would very much like to do so, I doubt seriously that I will ever be able to read the hundreds of books that comprise my personal library.

Be that as it may, there are few of these books that I have not scanned, extracted research material from, or used in a host of other ways. Yet, there are many volumes that are thumbed and worn, clearly showing the wear and tear of daily use. These are the old standbys: the books that I refer to almost every day in my research, writing, or lecture preparation. In short, mine is a working library that is put to constant and varied use.

What books does one find on a geologist's bookshelf? Their titles and subject matter are incredibly varied, for geology, like most sciences today, is highly specialized and fragmented into many disciplines. Yet as broad as the subject is, most geology books can be

lanet Earth

classified as dealing with either physical or historical geology. Physical geology is concerned with the structure and composition of the earth and with the physical processes that affect it. As geologists have learned more about the physical characteristics of the earth, other and more specialized fields of geology have developed. For example, the mineralogist confines his research to minerals, while rocks are investigated by the petrographer. The geomorphologist studies the earth's surface features and tries to explain the nature, origin, and development of landforms. On the other hand, the structural geologist attempts to account for the various types of rock deformation within the solid earth. Seismologists are interested in earthquakes and the earth's interior, volcanologists investigate the activities of volcanoes, and glaciologists study glaciers. Even more specialized are the geochemists and geophysicists: they analyze the earth in the light of data derived from chemistry and physics.

While the physical geologist concentrates on the physical aspects of our globe, the historical geologist is delving into the earth's past. He wants to know when and how it originated, what changes it has undergone, and how life has developed on its surface. Need-

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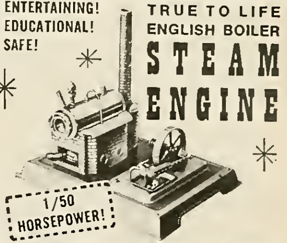

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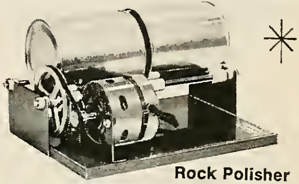

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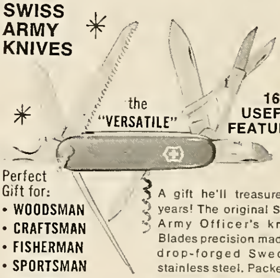

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— 1969 —

AUSTRALIA — N. Z. (3 tours)

Added by request, Australia tour leaves L.A. Oct. 25; New Zealand Nov. 15; N.Z. West Coast (2 wks) Dec. 6.

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— 1970 —

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Jan. 10—2 weeks from Wakulla Springs to northeast coast, across the prairies to Sanibel, Everglades and the Keys.

MIDDLE AMERICA (4 tours)

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TEXAS — MEXICO (5 tours)

Texas from Corpus Christi March 7; Taxco, Holy Week special; then Mexico West & East Coast.

PACIFIC COAST (7 tours)

Baja California camping, from Nogales Mar. 28; Arizona, from Tucson Apr. 25; Sierras, from San Diego May 9; Cascades, from Klamath Falls, May 20; followed by Alaska South, North and Outposts. Remarkable tropics-to-Arctic coverage of spring in Western North America.

EUROPE (12 tours)

Too much of a program to list here; by all means send for detailed brochure. Norway, Iceland, Russia and Siberia especially recommended. Twelve tours, extending through May, June, July.

CENTRAL AMERICA

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AFRICA (3 tours)

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Venezuela, Aug. 15; Colombia, Sep. 5; Ecuador/Peru, Sep. 26; Chile/Tierra del Fuego, October 24. Also Galapagos and Antarctica.

SOUTH PACIFIC (8 tours)

This is the year of full South Pacific coverage. Melanesia, Aug. 15 from Samoa; New Guinea, Sep. 5 from Rabaul; Western Australia, Oct. 3 from Perth; Australia East, Oct. 24 from the Barrier Reef at Cairns; New Zealand, Nov. 14 from Auckland; N.Z. West Coast, Dec. 5. Also special tours of New Guinea/West Irian north coast, and Western Australia wildflowers.

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less to say, these geologic investigations have resulted in voluminous writings on every facet of the planet that man calls home.

As a professor of geology and the author of nontechnical publications written especially for the lay person, the titles in my geologic library are almost as diverse as the processes and materials of the earth that they describe. I find that my research material ranges from aa—a type of lava—to zinc, and from the duck-billed dinosaur, *Anatosaurus*, to *Zeuglodon*, a fossil whale. Between these extremes is a bit of everything geologic. In recent years I have used my library as a source of information to try to bring an appreciation of geology to the man in the street, to explain rocks, minerals, and fossils to rockhounds, and to interpret the science behind the scenery in our national parks. These nontechnical publications generally tend to whet the reader's appetite for more knowledge on certain subjects that may particularly catch his fancy. Consequently, I receive many requests for sources of additional information regarding caves, volcanoes, earthquakes, dinosaurs, or some other specialized topic. There are also requests for more general information.

What books are usually recommended? This depends, of course, upon who wants to know about what, for the reader's background will usually determine what he can understand and enjoy. This is important. The typical reader of nontechnical science books in any field does not want a course in the subject. Rather, he is interested in learning as much as possible about a certain topic in the most enlightened possible way. For those who just want to know a little about geology there are several inexpensive paperbound volumes of selected readings. One of the best of these is the *World of Geology* by L. Don and Florence Leet. The Leets have assembled a series of easy-to-read articles on all facets of geology, each written by an authority in his field. The editors have arranged the articles in a meaningful geologic sequence and have provided a brief introduction to each. *The Crust of the Earth* is a similar paperbound collection of readings edited by Samuel Rapport and Helen Wright. John F. White's *The Study of the Earth* is more meaty stuff. White has gathered together a series of stimulating articles to introduce the reader to some of the scientific work of early and current workers in earth science. This, too, is in paperback. If one has some background in geology, but would like to delve more deeply into the subject, I usually recommend W. H. Freeman and Company's *Readings in the Earth Sciences*. This two-volume set consists of reprints of geology articles that have appeared in *Scientific American*. For the lay person who wants a broad—but more detailed—view of geology, these articles are unsurpassed.

For those who prefer a "broad-brush" treatment of geology, two books stand out because of their exceptional illustrations, a vital part of any geology book. Kirtley Mather's *The Earth Beneath Us* is a scholarly, but quite readable, introduction to the physical aspects of geology. *Geology Illustrated* is just that, for John Shelton's outstanding photographs prove that a good geologic illustration is indeed worth a thousand words. The reader who does much traveling by air will especially enjoy Shelton's explanations of his fine aerial photographs. Having had the unique experience of flying over the Rockies with Shelton while he piloted his plane with one hand and repeatedly clicked his Leica with the other, I can particularly appreciate this book.

The above books are heavily oriented toward physical geology, but *The Earth*, by Carl O. Dunbar, is more general in that it covers both the physical and historical aspects of planet earth. Judith Viorst's paperbound *The Changing Earth* is an introductory presentation of general geology, as is another paperback, *A Planet Called Earth*, by George Gamow. *The Earth*, by Arthur Beiser and the editors of *Life*, is a beautifully illustrated volume that covers virtually all phases of geology. In the same vein is *Anatomy of the Earth*, a French import by André Cailleaux. Those who want to learn the history of the geologic sciences along with basic geologic principles will enjoy Ruth Moore's *The Earth We Live On*. *Giants of Geology*, by Carroll Lane Fenton, tells the story of geology through the lives and research of some great geologists.

Leaning also toward physical geology—but more oriented toward landforms and their relation to the landscape—are *This Changing Earth* and *This Sculptured Earth*, both by John A. Shimer. Jerome Wyckoff's informative *Rock, Time, and Landforms* also interprets the landscape, and *The Geology of the National Parks: Their Landscape and Geology* (Vol. 1, *The Western Parks* and Vol. 2, *The Eastern Parks*) is my own attempt to explain the science behind the scenery in our national parks. Although relying rather heavily on European examples, G. H. Dury's *The Face of the Earth* is a good inexpensive paperbound introduction to the science of geomorphology.

The rise in popularity of rock and mineral collecting has brought with it an ever increasing number of publications dedicated to the rockhound. These range from old standards such

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Some topics are timely. Following a major earthquake or volcanic eruption, there is always increased interest in these awesome geologic phenomena. For example, as a result of the extended publicity on the alleged forthcoming "Great California Earthquake," interest in earthquake publications literally skyrocketed. Robert Iacopi's excellent *Earthquake Country: How, Why, and Where Earthquakes Strike California* is obviously *the* book on this topic. Unfortunately, few, if any, of the self-appointed California prophets of earthquake doom have read Iacopi's book. *Earthquakes —Discoveries in Seismology*, a paperback by L. Don and Florence Leet, is an interesting and comprehensive treatment of all phases of earthquake activity, past and present. *Earthquakes and Earth Structure*, by John H. Hodgson, and Elliott Roberts' *Our Quaking Earth* are two other fine nontechnical presentations of seismic phenomena. *Earthquake! The Story of Alaska's Good Friday Disaster*, by E. Engle, is a graphic account of the impact of a major temblor on man and his environment.

Interest in volcanoes was also heightened with the recent showing of the television documentary on Surtsey.

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THE LAST OF THE WILD is a magnificent collection of 160 color photographs by the famed German photographer and filmmaker Eugen Schuhmacher. Many of his subjects (which were taken all over the world) are rare, others are seldom seen. There is also an excellent supporting text describing the animals and the long expeditions he made to track them down. "Probably the best book of animal photographs ever published." Normal price $14.75.

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This volcano, which appeared off the coast of Iceland in November, 1963, has been studied in great detail. The fascinating account of the island's fiery birth is told by Sigurdur Thorarinsson in *Surtsey*. The color illustrations are breathtaking and the author's geologic background lends authenticity to his presentation. *Mountains of Fire*, by Genevieve Vaughan-Jackson, and *Chains of Fire*, by Kent H. Wilcoxson, are two interesting books about volcanoes and historic volcanic eruptions. Rupert Furneaux's *Krakatoa* is a vivid account of the devastating eruption of this famous East Indies volcano in 1883—an explosion estimated to have released one million times more energy than an H-bomb. Two recent additions to the popular literature on volcanoes are *The Circle of Fire*, by Carl Heintze, and *Kilauea: Case History of a Volcano*, by Don Herbert and Fulvio Bardossi. The latter tells the story of Hawaii's famous Kilauea Volcano, the volcano under constant observation by the United States Geological Survey.

Last—but far from least—there is Fred M. Bullard's classic *Volcanoes*. This sound, yet interestingly written, book is not only readable, it is a truly definitive work. Bullard has spent most of his life studying volcanoes the world around, and this treatise covers all phases of volcanism from the ancients' explanation of these great smoking mountains to the latest applications of geothermal energy.

Turning from hot to cold, there are some interesting books on glaciers and the great Ice Age. There is *The Great White Mantle*, by David O. Woodbury, and Gwen Schultz's inexpensive paperbound *Glaciers and the Ice Age*. But easily the most outstanding of these books is the late James L. Dyson's award-winning *World of Ice*.

Visitors returning from a visit to Carlsbad Caverns or Mammoth Cave frequently want to know more about caves and their origin. Some even seriously consider taking up the fascinating hobby of spelunking, or cave exploration. Unfortunately, there is limited fare in this area, for most books about caves deal more with cave adventures than with cave geology. However, William R. Halliday's *Depths of the Earth*; *Celebrated American Caves*, edited by Charles Mohr and Howard N. Sloane; and *Exploring American Caves*, by Franklin Folsom, provide a jumping-off point from which to learn more about caves and caving.

Because almost 71 percent of the earth is covered by water, the study of the hydrosphere, the waters of the earth, is also of interest to the geologist. For a general introduction to the sea, including its broader geologic aspects, *The Sea Around Us*, by Rachel Carson, is the logical place to begin. And *Oceanography*, written by geologist Warren E. Yasso, is a good introductory paperback with a strong geologic flavor. Generally speaking, the marine geologist is concerned primarily with the geologic work of the sea and the ocean floor. Unfortunately, most marine geology books are too advanced for general reading, but *Submarine Geology* and *The Earth Beneath the Sea* are two volumes that will provide the perceptive reader with a not-too-technical introduction to this rapidly expanding field. Both of these books were written by Francis P. Shepard, a well-known pioneer in ocean floor geology. Willard Bascom's informative paperback *Waves and Beaches* tells the story of marine erosion and deposition—the never-ending battle of the sea against the land. *The Deep and the Past*, by David B. Ericson

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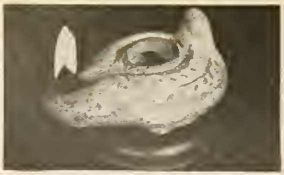

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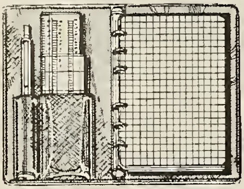

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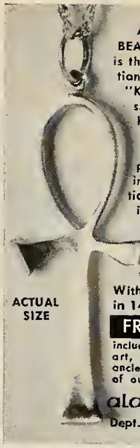
and Goesta Wollin, is an intriguing account of how scientists have used deep-sea sediments to solve puzzling geologic problems such as the dating of the Ice Age.

Because my major field of interest is paleontology, my library naturally has many titles relating to fossils and earth history. Most popular books on historical geology deal with some aspect of fossils, or what might generally be called prehistoric life. These books, like those concerned with rocks and minerals, vary greatly in size, cost, and quality. There are several books that will give the reader a feel for earth history without going into excessive detail. These include *The Story of Our Earth*, by Richard Carrington; Clifford Simak's *Trilobite, Dinosaur and Man; The World We Live In*, by the editors of *Life*; and *Life of the Past*, by George Gaylord Simpson.

Two paperbacks, R. A. Stirton's *Time, Life, and Man* and *Fossils: An Introduction to Prehistoric Life*, by William H. Matthews III, serve not only as introductions to historical geology but they also have a great deal of information on fossils and fossil collecting. *The Fossil Book*, by Carroll Lane Fenton and Mildred Adams Fenton, is well written and profusely illustrated. It provides a most excellent and comprehensive treatment of fossil plants and animals. From the standpoint of cost and convenience in the field, the "Golden Nature Guide" *Fossils*, by Frank H. T. Rhodes, Herbert S. Zim, and Paul R. Shaffer, cannot be beat. The color illustrations, collecting hints, and fossil identification tips make this an ideal primer for the neophyte fossil buff.

The History of Life, by A. Lee McAlester, and *Fossils, Paleontology, and Evolution*, by David L. Clark, are good treatments of the fossil record and an introduction to the basic principles of evolution. Both these paperbacks are well illustrated.

To the average person the words *fossil* and *dinosaur* are virtually synonymous; books and articles about these so-called terrible lizards never fail to fascinate readers of almost every age. In an attempt to woo this potentially large audience, many authors have ground out countless books on dinosaurs. But as might be expected, these vary greatly in accuracy, and some contain almost equal amounts of fact and fiction. Where can one turn for valid information in this reptilian morass? When in doubt, check the author: if it happens to be Edwin H. Colbert, buy the book! Colbert, The American Museum of Natural History's "Mr. Dinosaur," has made these extinct reptiles come to life in the minds of readers of every age. But more important, Colbert



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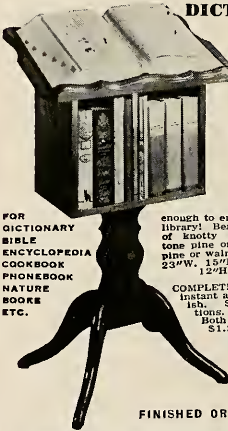

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tells it like it really was. In so doing he proves that in the hands of a gifted and competent writer, fact is indeed stranger than fiction. Starting with his classic, *The Dinosaur Book*, Colbert has given us *Dinosaurs, Their Discovery and Their World*; *The Age of Reptiles*; and more recently, *Men and Dinosaurs*. The last is a fascinating account of the famous bone-hunters who made the exciting fossil finds that resurrected the dinosaurs from their millions-of-years-old tombs. Another first-rate Colbert book is *Evolution of the Vertebrates*. Somewhat more technical than the aforementioned Colbert books, this well-known and readable treatment of vertebrate evolution is now available in a paperbound edition. Space limitations preclude listing the host of published dinosaur books, many of which are quite good. However, two excellent paperbacks, written by well-qualified vertebrate paleontologists, must be mentioned. These are *Dinosaurs*, by Nicholas Hotton III, and Björn Kurtén's *The Age of Dinosaurs*. For those who have had their appetites whetted by Colbert's *Men and Dinosaurs*, there is *The Dinosaur Hunters*, by Robert Plate. This is a dual biography of Othniel C. Marsh and Edward D. Cope—those belligerent dinosaur hunters whose famous feud started the dinosaurs on their road to fame.

Books on evolution are equally at home on the biologist's or geologist's bookshelf. Here again, there is a broad spectrum of titles available for consideration. Among the not-too-technical volumes that might be of particular interest to the geologically oriented reader are the provocative *Man, Time, and Fossils*, by Ruth Moore, and the comprehensive *Atlas of Evolution*, by Gavin de Beer. *Evolution*, by Ruth Moore and the editors of *Life*, and *The Evidence of Evolution*, by Nicholas Hotton III, are both good survey-type books and superbly illustrated. Less expensive, but equally comprehensive, are the paperbound *Evolution in Action*, by Julian Huxley; *Processes of Organic Evolution*, by G. Ledyard Stebbins (heavy on biology); *The Evolution of Life*, by Everett C. Olson; and George Gaylord Simpson's *The Meaning of Evolution*.

Any review of this sort must of necessity only sample the many fine nontechnical books that will open up the stimulating world of geology. It is obvious that many more excellent paperback and hard-cover books could have been mentioned. But those that are listed can lead to other books, for most have excellent bibliographies. These references will provide additional titles on similar subjects. Hopefully, time will be taken to read these and other books about earth and its history. You will be the richer for it, because even a passing acquaintance with geology can greatly enhance one's appreciation of this remarkable planet called Earth.

William H. Matthews III is Professor of Geology at Lamar State College of Technology in Beaumont, Texas.

THE MOUNTAINS OF SWITZERLAND, edited by Herbert Maeder. *Walker and Company, $17.50; 288 pp., illus.*

This is an ideal book to discover on the display table of a dentist's waiting room: at someone else's expense you can divert yourself for half an hour by experiencing vicariously the beauty and thrills of mountain climbing in the high Swiss Alps. The editor, a "mountain climber by calling and photographer by profession," has assembled 208 pages of magnificent

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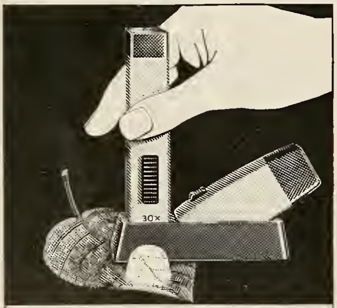

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photographs conveying the intimate, as well as the panoramic, aspects of alpine mountaineering. A few picture captions will effectively characterize the volume:

"The Zmutt ride on the Matterhorn forms one of the finest climbing routes in the Alps."

"René Arnold, Paul Etter and the author, wrapped in wadded jackets and sleeping bags, have spent a cold night (-15° C.) sitting on a narrow ridge of rock on the Italian summit."

"A fairy castle formed of glittering blue-green ice on the Sella glacier."

In an effort to make of the book more than "one of those sentimental 'mountain stream and edelweiss' products," Maeder has assembled 80 pages of words to accompany the photographs. Of these, 15 pages are uninspired appendixes (The Alpine Fauna, Scale of Difficulty for Rock Climbing, Index to the Peaks of the Swiss Alps, Technical Details of Photographs); 19 pages review the history of mountaineering in the Alps; 21 pages treat mountaineering as a sport, and 25 pages review the geology and biology of the Alps.

The best part of the text is the historical section by George Grosjean on the exploration and opening of the Swiss Alps. Until the Renaissance, educated people looked upon mountains with fear and superstitious awe. Grosjean sketches the history of Alpine exploration, beginning with a 1518 climb by Joachim Watt, who aimed at destroying the superstition that the ghost of Pontius Pilate lay in the lake of Mount Pilatus. Most readers, however, will find far too much historical detail in this section.

That portion of the text dealing with Alpine geology and biology is the most disappointing. It is poorly organized, generally superficial, and in many instances will mislead or confuse the reader. The entire discussion of rock types, for example, is contained in a single, undivided paragraph written in stream-of-consciousness style and filled with errors and confusion: rocks with a granular structure are wrongly called "basic rocks," and metamorphic rocks are described as coming only from magmatic types. Still worse, the most important, interesting, and characteristic phenomenon of the Alps—their internal structure—is expounded without diagrams and with confusing references to complex tectonic theories. The concept of isostasy, for instance, is explained in one parenthetic expression as "study of the degree of a compensating balance between the hard earth's crust and the magma underneath." This reviewer would argue that it is a mistake to attempt to explain, without diagrams, such a complex concept as isostasy in

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a single phrase, but at least let the phrase be accurate: isostasy is a condition of flotational equilibrium between adjacent portions of the earth's crust.

Portions of the section on Alpine biology are interesting and clear—that part dealing with hibernation, for example—but in general, the coverage is that of a monotonous catalog.

In sum, the book is a beautiful and expensive paean to the exhilarations of Alpine mountaineering: no less, but certainly no more. *Caveat emptor.*

JOHN IMBRIE
Brown University

Briefly Noted:

YIWARA, by Richard A. Gould. *Charles Scribner's Sons, $8.95; 239 pp., illus.*

Dr. Gould gives a vivid, personal account of more than a year spent among the nomadic aborigines of Western Australia. The author previously explored the manufacture and use of stone tools by these people in his article, "Chipping Stones in the Outback" (NATURAL HISTORY, February, 1968).

C.B.

A LITTLE ABOUT LOTS. *The Park Association of N.Y.C., $.50; 62 pp.*

In New York City every square inch of open space is important—for parks, for play areas, for a place to sit. This situation has prompted the authors, a group of volunteers from the Park Association of New York City, to compose "the do-it-yourself book on improving vacant lots and neighborhoods," a concerned layman's guide to making the city's nooks and crannies a little more usable.

The authors have had firsthand experience with the several aspects of lot-improvement—obtaining funds, installing facilities, purchasing insurance, coping with vandalism, planting trees—and in their little book, they tell you how to go about it. The booklet is informative, concise, complete, and practical—even enjoyable to read.

J.H.

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6—Gerald Carson
26-27—AMNH
29-35—Jerry Cooke
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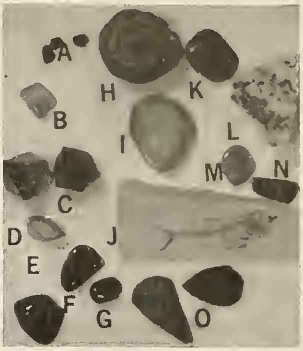
66-67—William Garnett, courtesy of Random House
Errata: November issue, pp. 32-45—black-and-white photos, T. Avery; map, Eric Engstrom

FOSSILS - MINERALS - SHELLS

TELESCOPES - MICROSCOPES
CHEMICALS - SCIENCE BOOKS
APPARATUS - PRESERVED SPECIMENS



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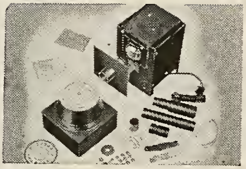

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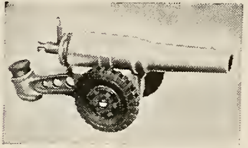

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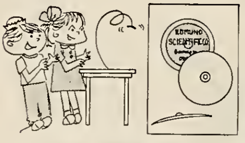
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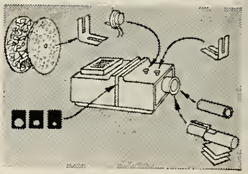

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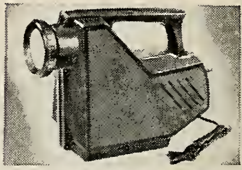

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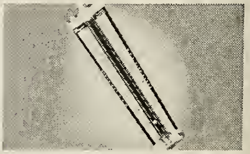

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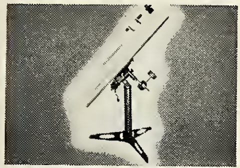

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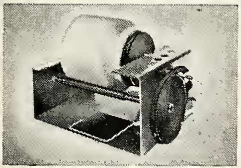

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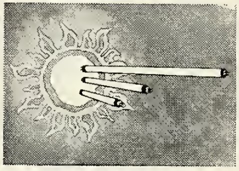

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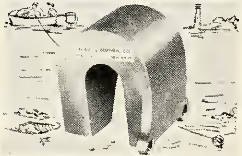

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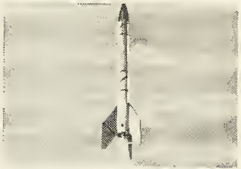

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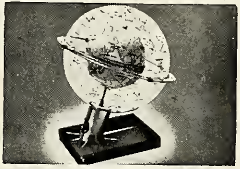

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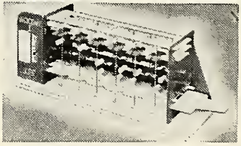

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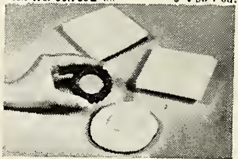

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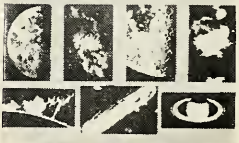

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EATING CHRISTMAS IN THE KALAHARI

The Harmless People. E. M. Thomas. Alfred A. Knopf, Inc., New York, 1959.

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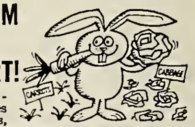

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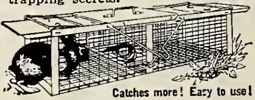

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